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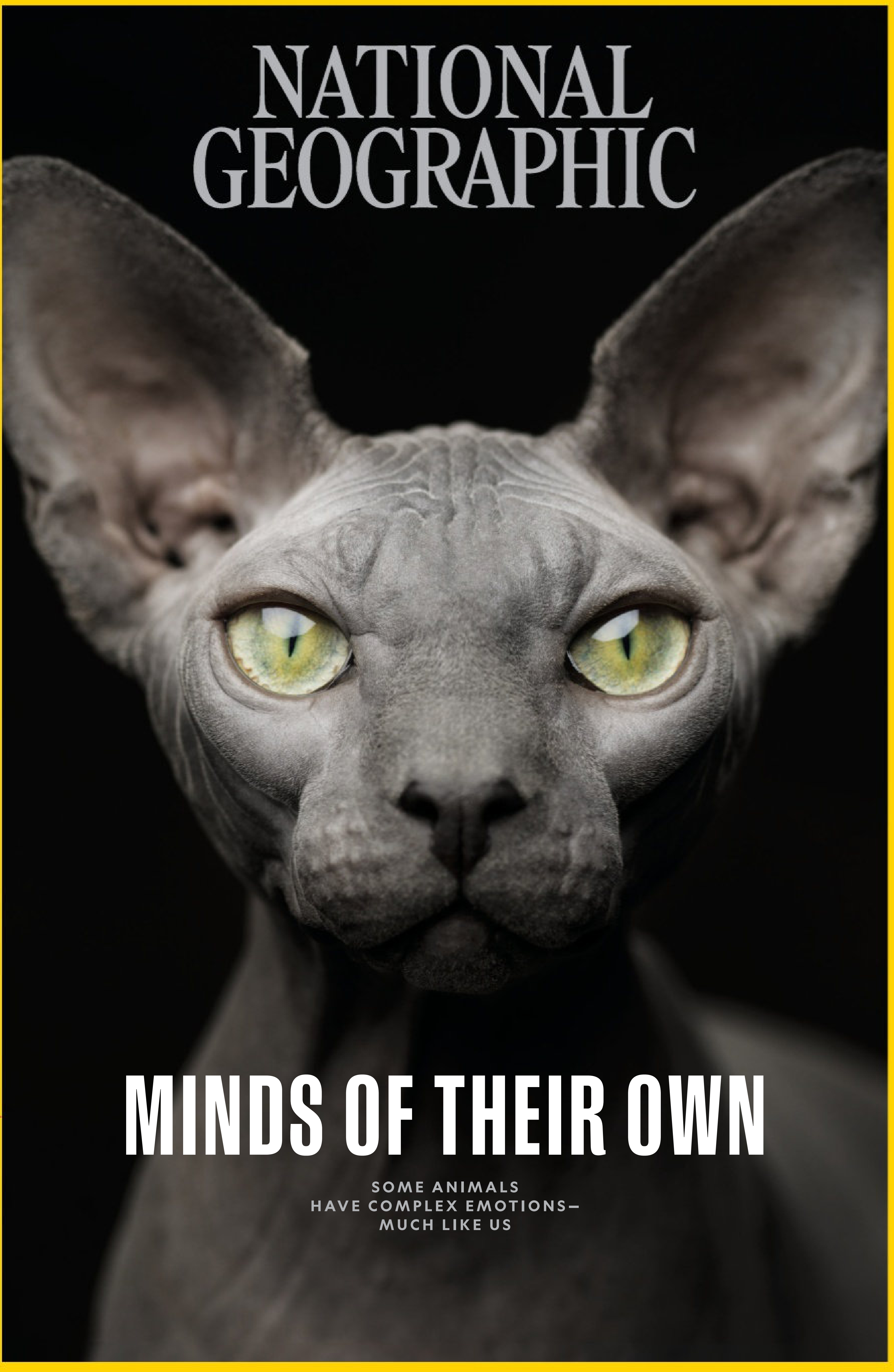
NATIONAL GEOGRAPHIC



MINDS OF THEIR OWN

SOME ANIMALS
HAVE COMPLEX EMOTIONS—
MUCH LIKE US

VISIT…

LANZAROTE
Caliente.com

NATIONAL GEOGRAPHIC AND ROLEX PERPETUAL PLANET TUPUNGATO VOLCANO EXPEDITION TEAM

TOPHER WHITE, CONSERVATION TECHNOLOGIST

CRISTIAN DONOSO, EXPLORER

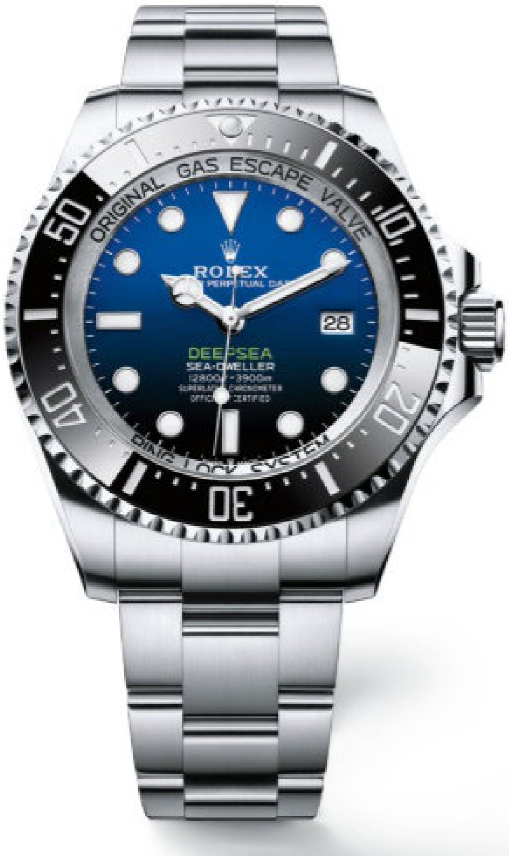
FRANCESCO SAURO, EXPLORER

GHISLAIN BARDOUT, EXPLORER

WHAT DO THEY SEEK?

Explorers, adventurers, scientists. Men and women who always broadened the horizons, for all humankind to share. Rolex was at their side when they reached the deepest point in the oceans, the highest summits of the Earth, the deepest jungles and both poles. But now that we know, more than ever, that our world has its limits, why do they continue to venture out there, again and again? Certainly not for kudos, accolades, or an ephemeral record. What they truly seek is to understand more intimately how complex and delicate our planet is, to document its change and how together, we can affect it for the better. So as long as they need it, we will be at their side. Because today, the real discovery is not so much about finding new lands. It's about looking with new eyes at the marvels of our planet, rekindling our sense of wonder, and acting to preserve our pale blue dot in the universe…
Doing our very best for a Perpetual Planet.

#Perpetual



OYSTER PERPETUAL
ROLEX DEEPSEA

ROLEX

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On the Cover
Ed, a Canadian sphynx cat, is curious, outgoing, affectionate, and highly responsive to human emotion. He's also talkative: Say his name, he purrs. In this portrait, his forward-tilted ears show he's alert and his narrowed pupils that he's relaxed.
VINCENT LAGRANGE

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Creatures of the Night

Using darkness as his canvas and light as his brush, a photographer creates such works of whimsy as a sprinting dinosaur and a rainbow-hued spider.

PHOTOGRAPHS BY DARREN PEARSON

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THE BIG IDEA

Live Longer by Living Younger

We can self-engineer genetic changes that boost longevity by making healthy choices.

BY MICHAEL F. ROIZEN, M.D.

INNOVATOR

Catherine de Medici Jaffee

She produces podcasts at the crossroads of science and social justice.

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Come-Hither Croaks

Soprano or baritone? Female wood frogs show a clear preference for deep male voices.

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Archaeologists aim to decode the secrets of Rathcroghan, an ancient Irish capital with a secret gateway to the underworld.

BY RONAN O'CONNELL

ALSO

A High-Wire Act
Explorer Bertie Gregory

ABOVE: Working for tips from passing drivers, 10-year-old Rafiullah repairs damage from roadside bombs on Afghanistan's National Highway 1.

FEATURES

Animal Sentience: What Are They Thinking?

A few decades ago, most scientists didn't consider the minds of animals worth studying. Today there's growing appreciation of animals' complex consciousness—and recognition that emotions didn't evolve in human beings alone.

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ANIMAL SENTIENCE

Wondering What They're Thinking

BY **NATHAN LUMP** PHOTOGRAPH BY **MARTIN USBORNE**

UNTIL RECENTLY I lived in a magical corner of the city of Seattle, on a hillside overlooking Puget Sound, surrounded by thick stands of big-leaf maples interspersed with mature fir, cedar, and spruce trees. My husband, Charles, and I shared this patch of nature with abundant wildlife: coyotes, weasels and river otters, deer, and all manner of birds.

In our last few months there, we became transfixed by ongoing hostilities between a barred owl roosting in one of our maples and a murder of crows. No matter the time of day, when the crows spotted the owl, they would surround it, caw incessantly, dive-bomb, and generally harass the bird.

It was hard not to feel sorry for the owl, which was, to my mind, simply trying to get some rest before the evening's hunt. Though Charles reminded me that the two species don't get along, I kept thinking about these crows' relentlessness. Why did they have it in for this owl? Did they remember some injury it had done to them? Did they *feel* something toward it?

Behavioral science's progress in uncovering what animals think—and, yes, feel—is the subject of this month's cover story. It's a thought-provoking look at key discoveries to date on matters from dog pleasure and disappointment to rat kinship to dolphin joy. As it happens, contributing writer Yudhijit Bhattacharjee met a biologist who studies ravens—cousins of those American crows on my property—and has documented the birds consoling each other. So perhaps it's not so far-fetched to think my crows were harboring a grudge.

Wherever our cover story takes your mind, the research on animal sentience likely will have wide-ranging implications for how we regard, and treat, Earth's creatures in the years to come.

We've got other compelling features this month too: a journey through the Taliban's Afghanistan, a descent into astonishing (and melting) Alpine ice caves, and an exploration of the unique culture of Brazil's *quilombos,* communities established by Africans who escaped enslavement.

We hope you enjoy the issue.

Both scientists and artists have long contemplated the mystery of what goes on in animals' minds and what it could mean for our relationships with them. For his book *The Silence of Dogs in Cars,* photographer Martin Usborne captured this Great Dane named Alfie, a composite image of two photographs. Usborne says he doesn't presume to guess what animals might be feeling in his portraits—but "it's important to recognize them as independent beings who no doubt share in our fears and joys of the world."

Blackmagicdesign
ATEM Mini Pro model shown.

Introducing ATEM Mini Pro

The compact television studio that lets you create presentation videos and live streams!

Blackmagic Design is a leader in video for the television industry, and now you can create your own streaming videos with ATEM Mini. Simply connect HDMI cameras, computers or even microphones. Then push the buttons on the panel to switch video sources just like a professional broadcaster! You can even add titles, picture in picture overlays and mix audio! Then live stream to Zoom, Skype or YouTube!

Create Training and Educational Videos

ATEM Mini's includes everything you need. All the buttons are positioned on the front panel so it's very easy to learn. There are 4 HDMI video inputs for connecting cameras and computers, plus a USB output that looks like a webcam so you can connect to Zoom or Skype. ATEM Software Control for Mac and PC is also included, which allows access to more advanced "broadcast" features!

Use Professional Video Effects

ATEM Mini is really a professional broadcast switcher used by television stations. This means it has professional effects such as a DVE for picture in picture effects commonly used for commentating over a computer slide show. There are titles for presenter names, wipe effects for transitioning between sources and a green screen keyer for replacing backgrounds with graphics.

Live Stream Training and Conferences

The ATEM Mini Pro model has a built in hardware streaming engine for live streaming via its ethernet connection. This means you can live stream to YouTube, Facebook and Teams in much better quality and with perfectly smooth motion. You can even connect a hard disk or flash storage to the USB connection and record your stream for upload later!

Monitor all Video Inputs!

With so many cameras, computers and effects, things can get busy fast! The ATEM Mini Pro model features a "multiview" that lets you see all cameras, titles and program, plus streaming and recording status all on a single TV or monitor. There are even tally indicators to show when a camera is on air! Only ATEM Mini is a true professional television studio in a small compact design!

ATEM Mini	**US$295**
ATEM Mini Pro	**US$495**
ATEM Mini Pro ISO	**US$795**

Learn more at www.blackmagicdesign.com

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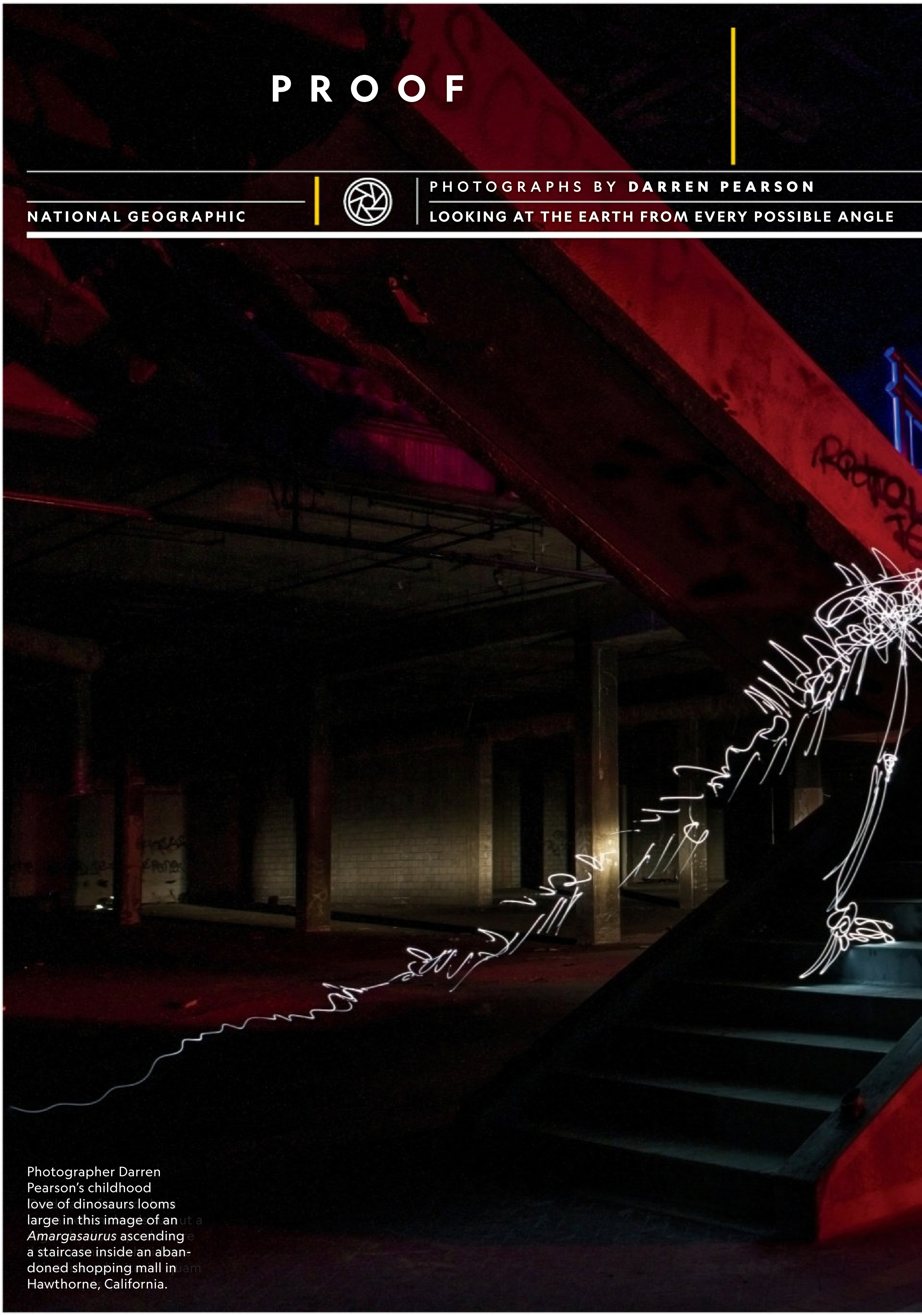
PHOTOGRAPHS BY **DARREN PEARSON**

LOOKING AT THE EARTH FROM EVERY POSSIBLE ANGLE



Photographer Darren Pearson's childhood love of dinosaurs looms large in this image of an *Amargasaurus* ascending a staircase inside an abandoned shopping mall in Hawthorne, California.

CREATURES OF THE NIGHT

Using light as a paintbrush and darkness as his canvas, a photographer creates works of whimsy.

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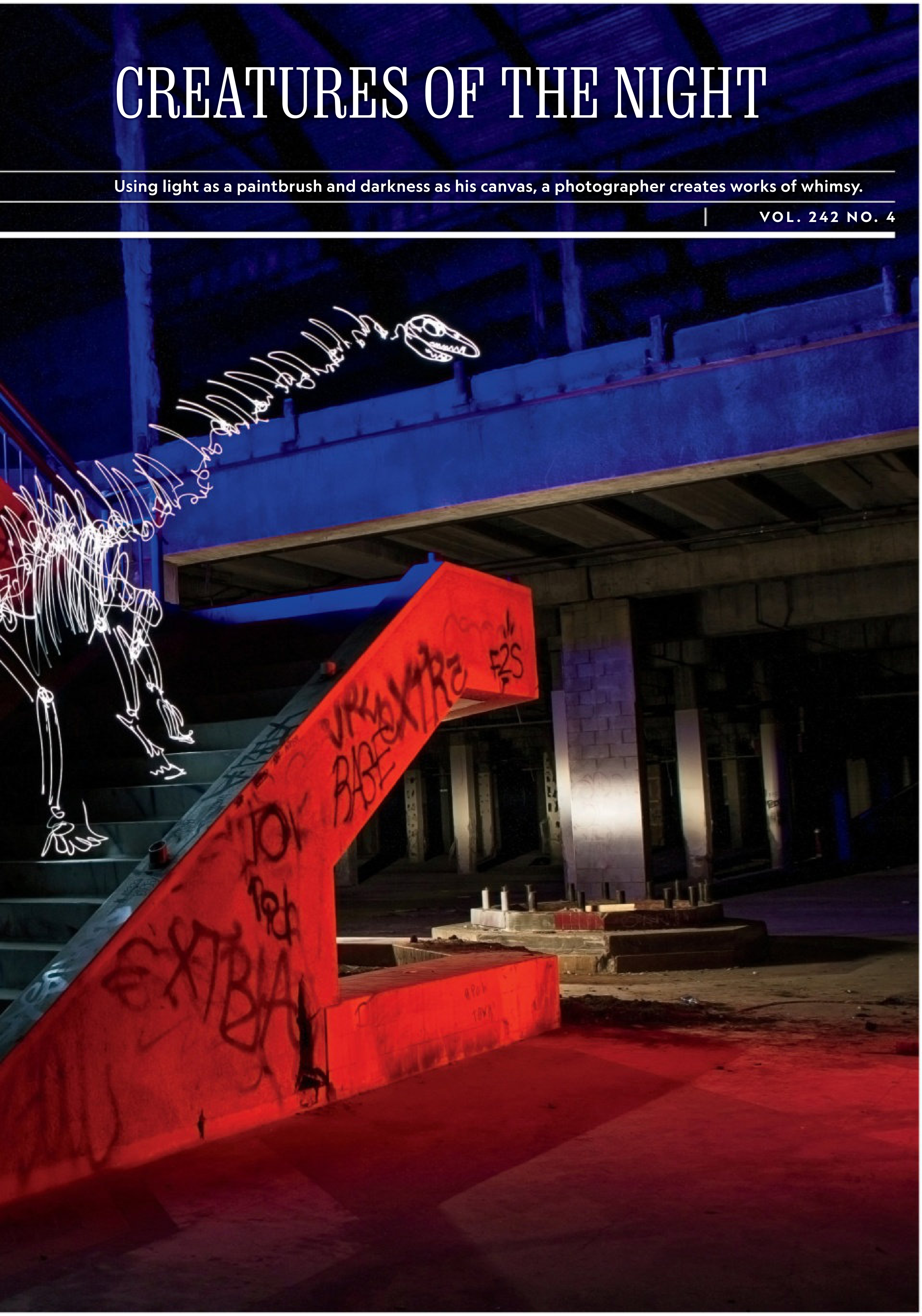
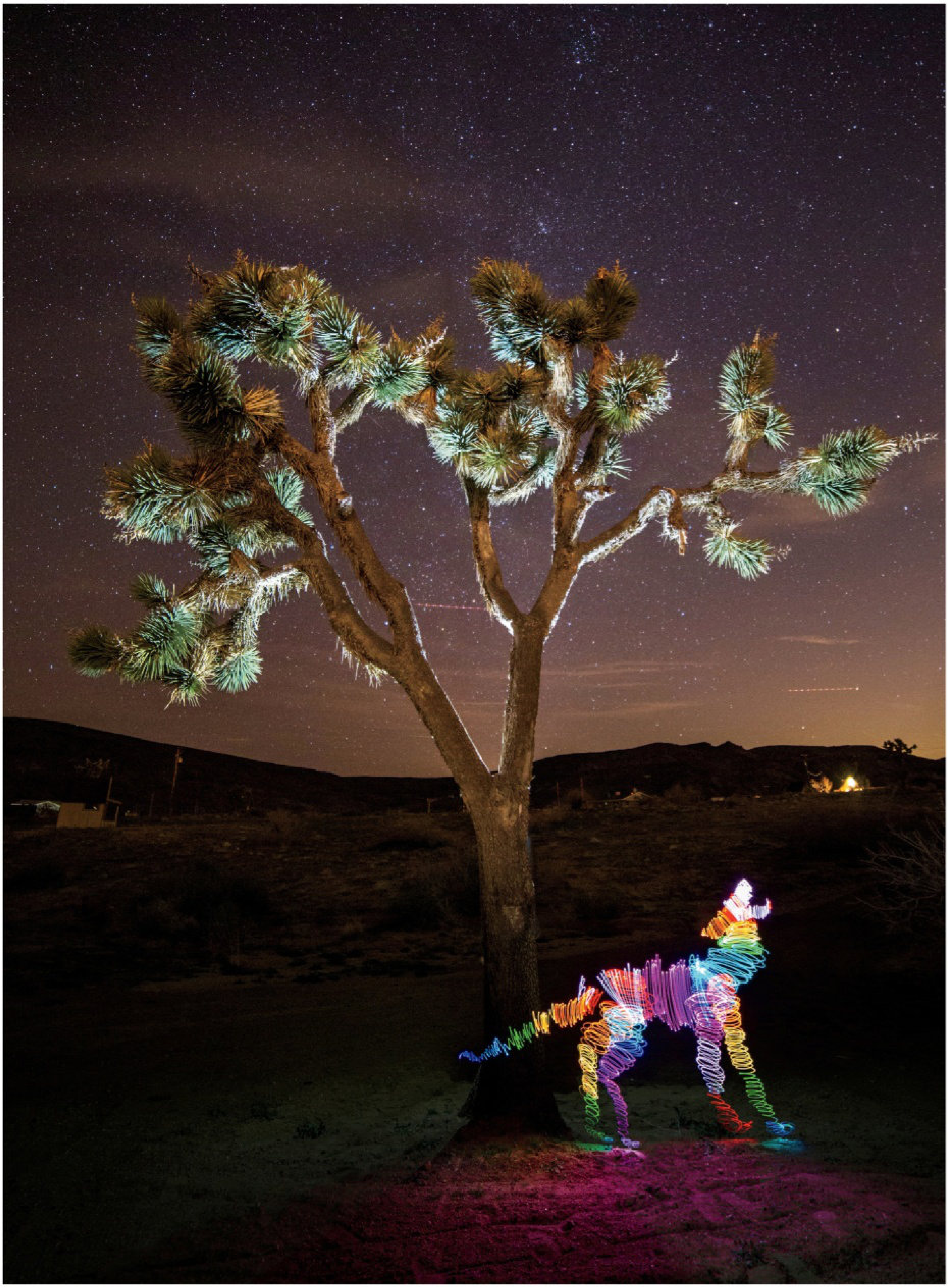
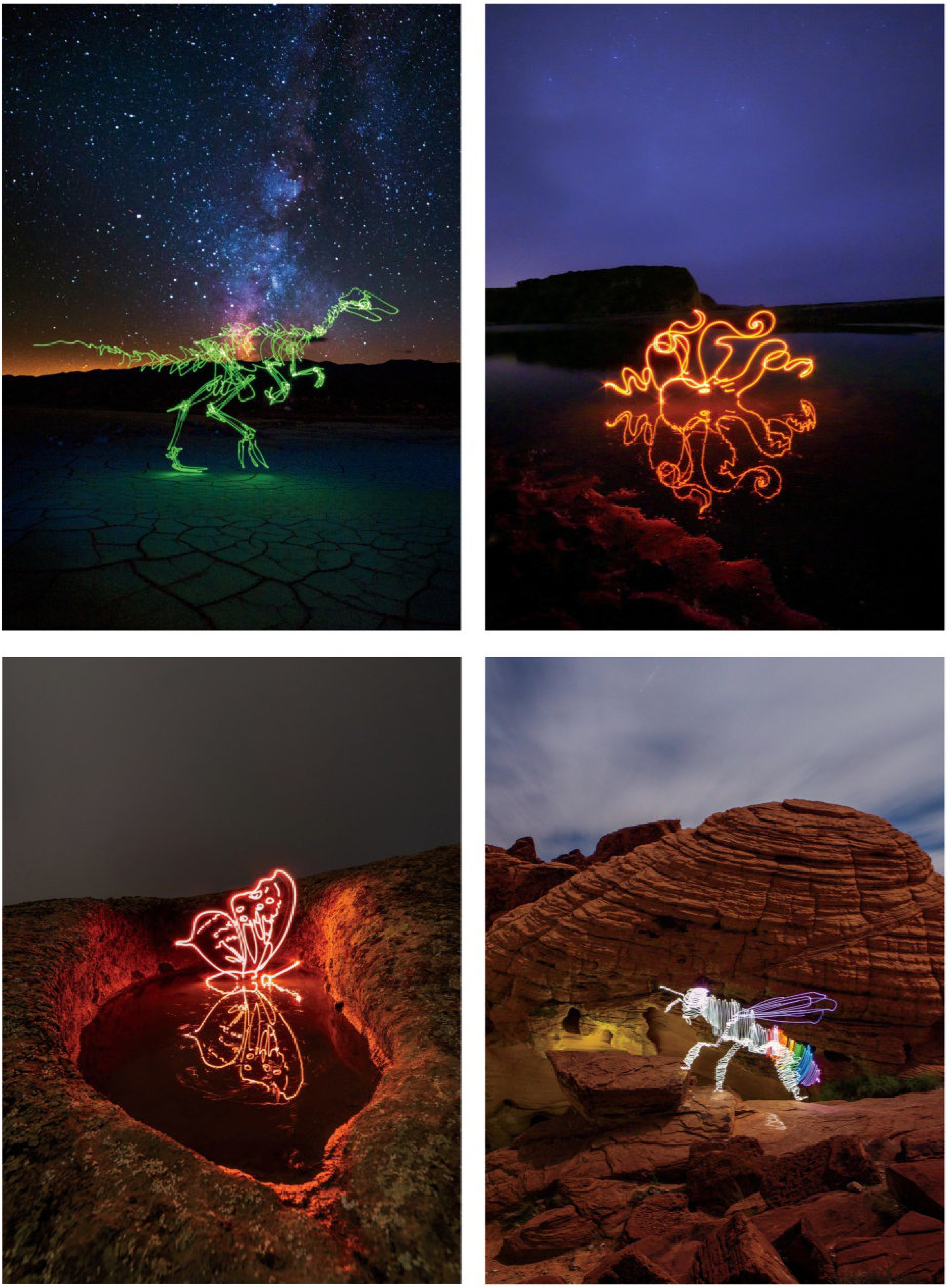
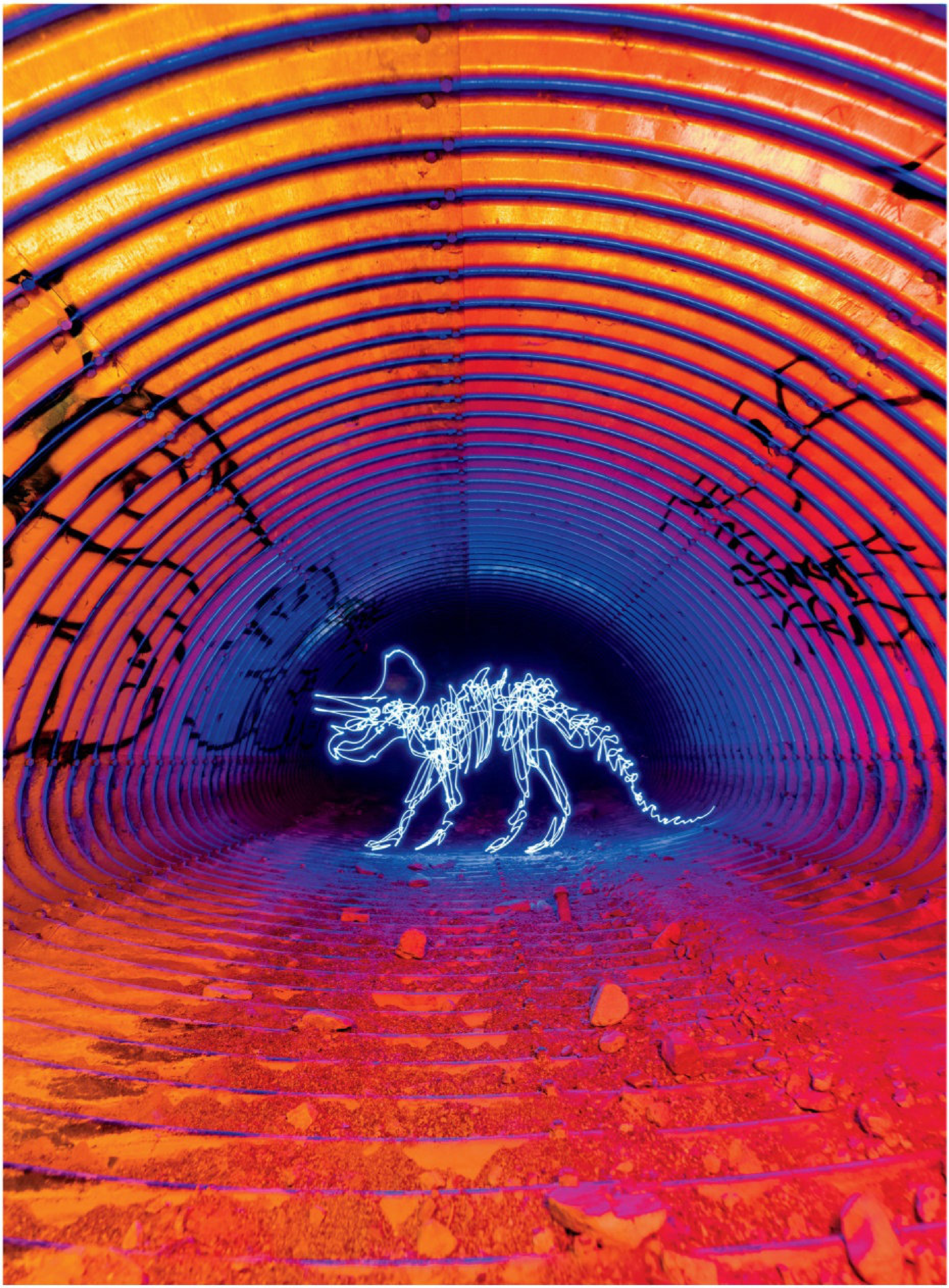




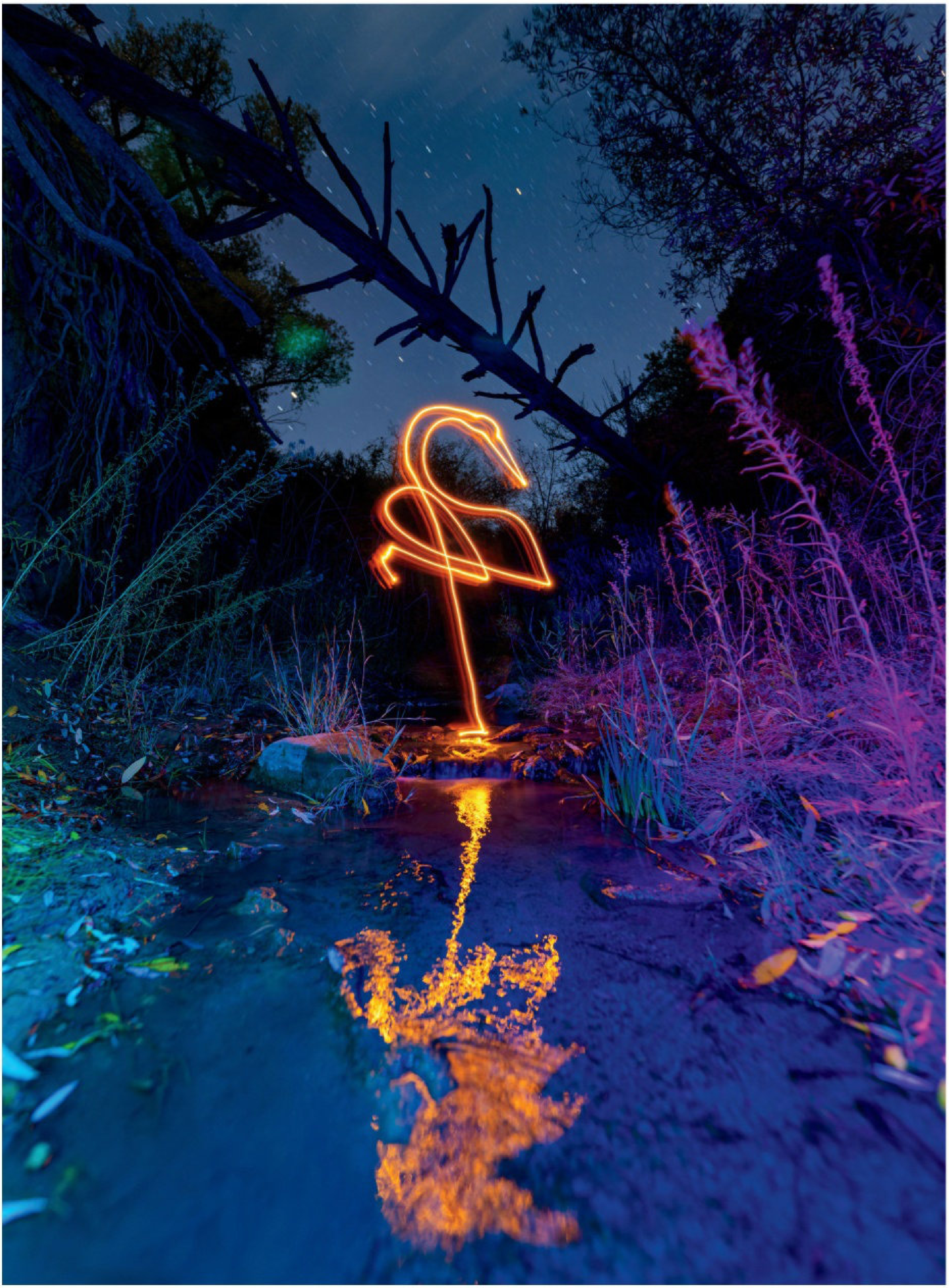
In an image that's a composite of two exposures, a coyote in rainbow hues howls to the sky near California's Joshua Tree National Park. Iconic landscapes of the western United States inspire Pearson, who is passionate about their value: "The environment impacts everything," he says. "Animals rely on it, and we rely on it—and yet we treat it with such disrespect."



Clockwise from top right: An octopus hovers in Big Sur, California; a bee alights in the Beehives area of Nevada's Valley of Fire State Park; a butterfly brightens a spot near Pearson's California home; and a *Gallimimus* stalks California's Badwater Basin in Death Valley. To capture the dinosaur against the stars, Pearson merged two exposures into one image.



Sometimes ideas come from unlikely places, such as this drainage pipe in California's Los Padres National Forest. Pearson saw it while hiking, then returned that night to transform the graffitied, corrugated metal into a backdrop for a *Triceratops*.



Pearson's designs often exhibit a gestural quality featuring a frenzy of energetic lines. But he has also developed a series of spare, single-line light paintings, such as this heron reflected in a seasonal creek near his home.

THE BACKSTORY

A GRAPHIC ARTIST TURNED PHOTOGRAPHER 'PAINTS' WITH LIGHT AND ILLUMINATES THE PASSAGE OF TIME.

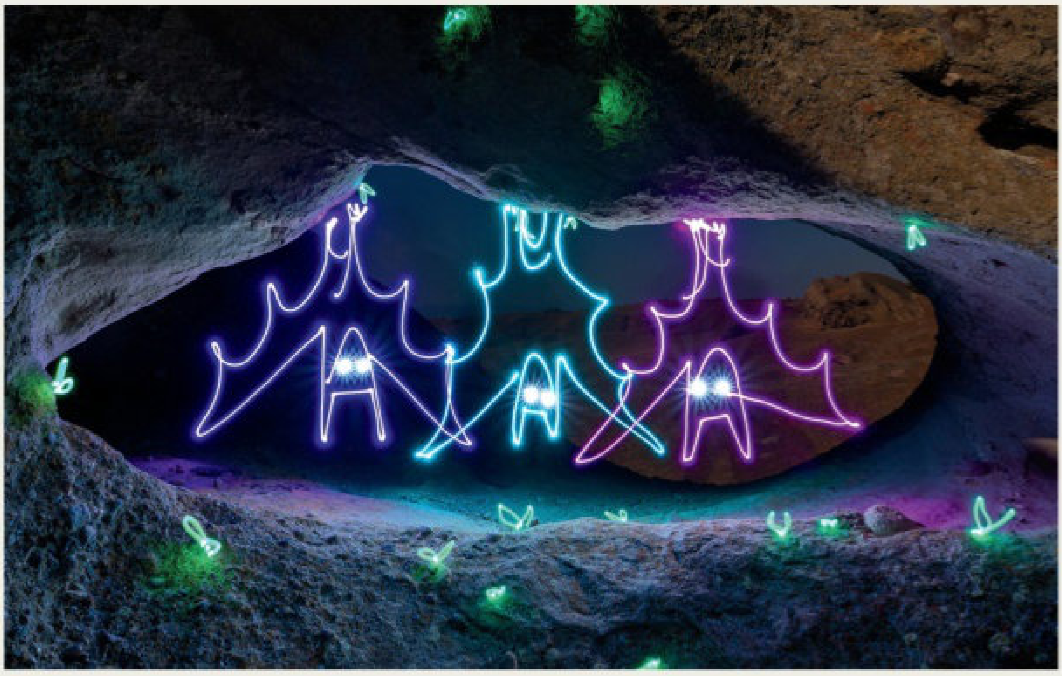
A CHANCE ENCOUNTER with a coffee-table book set graphic designer Darren Pearson on a new artistic path. He was charmed by one element in particular: a 1949 black-and-white photograph of Pablo Picasso at work. But instead of a brush, Picasso is using a light to "paint" his creation in midair. "I was captivated," says Pearson. "I was like, How is this possible?"

Photographer Gjon Mili was able to capture Picasso creating objects with light by setting his camera to a slow shutter speed. Pearson, founder of the light-painting company Dariustwin, now uses that same long-exposure technique—but he doubles down on the artistry, taking the photos and painting the subjects. And he works only at night.

Pearson begins by placing his camera on a tripod, aimed at the desired backdrop. Then, wearing black to disappear into the darkness, he steps in front of the lens and starts painting. His tool, which he designed and calls the Night-Writer, resembles a marker with interchangeable colored tips. To the casual observer, he might look like someone frantically searching with a flashlight for lost keys, he says. But he's actually sketching a life-size image of a subject from his mind's eye.

Several muses are evident in Pearson's work. Dinosaurs make frequent appearances: "That's the five-year-old me who wanted to be a paleontologist," he says. Rugged landscapes also recur, especially those of California, where Pearson lives in a cabin in the woods with his wife, Jordan, and their young son, Jasper.

Pearson is also fascinated by time, not only the hundreds of millions of years represented by rock formations but also the brief spell of a 30-second shutter speed. Subtle shifts occur even within those short periods, he says. "The stars move, the moon creates shadows. You have a natural evolution of time." —CATHERINE ZUCKERMAN



Pearson had to crouch under a rock formation in Los Padres National Forest to create this trio of bright-eyed bats encircled by sprouting vegetation; the image combines three exposures.

Legends of Spain

Beyond traditional draws of sun, sea, and sand, an ancient side of Spain—where legends were born—awaits discovery.

Few places can boast of myths quite as connected to the land as Spain. Its primordial mix of historic cultures layered upon wildly diverse landscapes has inspired storytelling so rich, all travellers need to do to discover it is to explore Spain's more curious, undiscovered corners.

Within the ravines of Asturias' Picos de Europa mountain range, folklore speaks of a winged, dragon-like serpent cloaked in shadow. To the east, you'll hear whispers of siren-like creatures from the seafaring mythology of the Basque Country. And below the mountains and inland, Spain's vast central region nurtures tales as tall as giants...

Top: Naranjo de Bulnes, Picos de Europa, Asturias.
Bottom: Bay of Biscay, Basque country.
Right: Windmills in Campo de Criptana, Castilla–La Mancha.

Mysteries of a medieval kingdom

A view of the valleys surrounding Sotres, a village in the Picos de Europa range, Asturias.

The dramatic landscape of Asturias reaches into coasts and mountains that hold secrets to thousands of years of mythology, history and gastronomy.

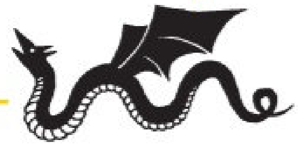
In the mountains of Asturias, the border between earth and sky is rock-hard and razor-sharp. It seems only natural that these soaring massifs should give rise to a mythical monster like the cuélebre. According to folktales, that dragonlike winged serpent dwells here, guarding treasures within folds of limestone, emerging to devour cattle—not to mention the occasional herder, maiden, or monk. The creature's domain spans the ridgelines of the Picos de Europa range, and orbits multiple UNESCO-protected biospheres. Muniellos, for example, is the largest oak forest in Spain. Wild boar and wolves move between the trees, as well as the Cantabrian brown bear—a population recovering from the edge of extinction.

Guided tours now run deep into the wilderness, and there's a real sense of discovery for first-timers in this quiet pastoral corner of 'Green Spain'. Hikers and cyclists will instead find shaded groves and grassy pastures, sheer rock faces and luminous glacial waters.

Perhaps the cuélebre is also a relation of the dinosaurs who left fossils and footprints on the 'Dinosaur Coast' between Gijon/Xixón and Ribadesella/Ribeseya. The prehistoric past does not feel so distant along these cliffs, and nearby Tito Bustillo cave is awash with ancient images of humans, ice-age mammals, and even a whale dating back as far as 35,000 years.

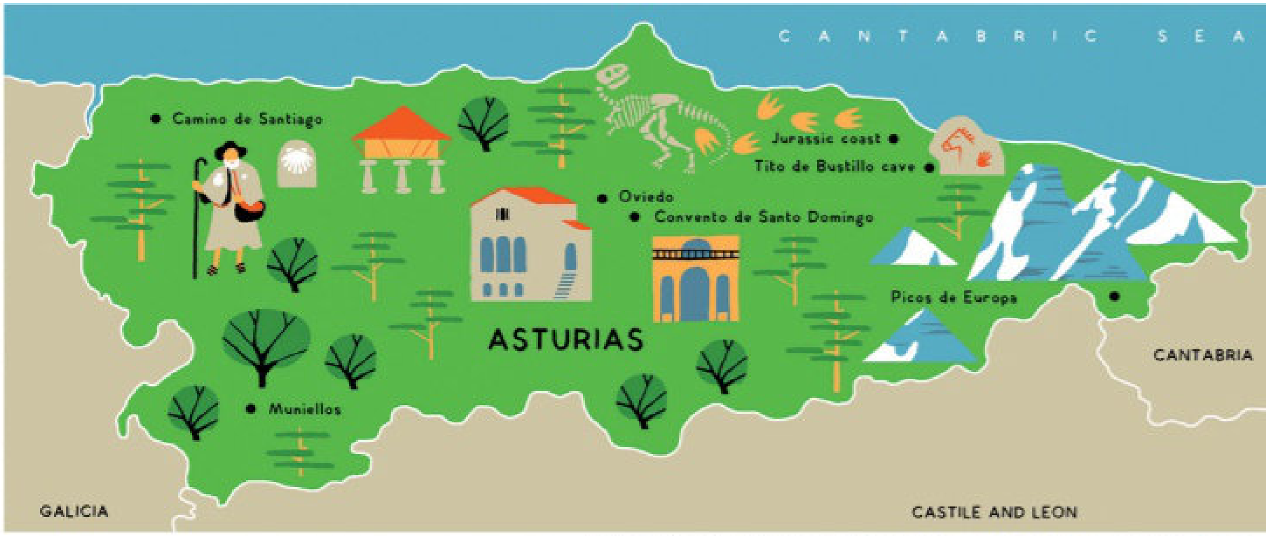
If these forms must be considered treasures, we can say the same of other riches created in Asturian caves, such as Cabrales—a tangy cheese named after the mountain community where it is matured in limestone caverns. In the old stories, the monster is often appeased with offerings of dairy produce. There's a ring of truth to this, as the Asturians' abiding love of food lends the regional cuisine its own power and depth, and tends toward generous portions.

> **Ideally, the wanderer will come down from the peaks ravenous and ready to feast at a sidrería, or cider house—where the regional icon is 'thrown' into the glass from a height in an aerating flourish.**



An associated spirit of conviviality extends from tiny rural pubs, to seaside fish restaurants in Llanes, to whole clusters of bars in the capital, Oviedo/Uviéu, or Gijón/Xixón, the biggest city in Asturias.

Legend tells of an unusually low-lying cuélebre lair in Oviedo, just behind the Convent of Santo Domingo. The creature kept eating the residents until a canny monastery chef fed it bread full of pins and nails, thus slaying the dragon. Such a victory is celebrated at the start-of-summer fiesta of San Juan/San Xuan. This is when the cuélebre is said to be weakest, as Asturias burns bright and the forces of darkness retreat.


CANTABRIC SEA
Camino de Santiago
Jurassic coast
Tito de Bustillo cave
Oviedo
Convento de Santo Domingo
ASTURIAS
Picos de Europa
CANTABRIA
Muniellos
GALICIA
CASTILE AND LEON

Top left: Jose Mier, a retired shepherd in Asturias, claims he saw a cuelébre when he was 13 years old. **Bottom left:** Stone ruins above the village of Sotres, Picos de Europa, Asturias. **Bottom right:** Cheesemaker Pablo Asiegu visits a cave used to store Cabrales cheese in the Picos de Europa mountain range, Asturias. ***Map by:*** *Guillermo Trapiello.*

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Sailors, sirens and surfers of the Basque Coast

Here on the Bay of Biscay you'll find fishing villages steeped in age-old Basque maritime culture.

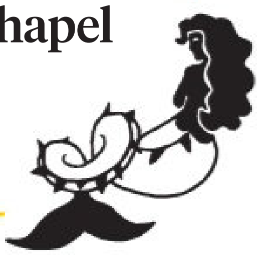
San Juan Gaztelugatxe, Bay of Biscay, Basque Country.

Her name is Xixili. She looks very like a mermaid, though her tail ends in a pair of duck feet. She sits on the breakwater at Bermeo, staring out over the Bay of Biscay. This landmark statue represents a prime specimen of a lamia—a creature from the seafaring mythology of the Basque Country.

Legends say the lamiak once lived along this coast saving local fishermen, as Xixili herself was said to do. Others of her kind were known to lure and drown sailors according to their whims. In that sense, the lamia is a perfect metaphor for the Cantabrian Sea, which has provided a livelihood for many generations of mariners from this port and others like it, while also cultivating legions of widows. Much of this history is documented at the Fishermen's Museum, which occupies Bermeo's Gothic 15th-century Ercilla Tower that rises over the Old Town's brightly painted houses. Here, you'll learn about the history of Basque shipbuilding and fishing that dates back centuries. Discoveries from the nearby Santimamiñe cave (which also allows guided tours) include nets and bone hooks found amid eerie galleries of paleolithic charcoal paintings.

By the early Renaissance, local seafarers had built an empire on sturdy wooden vessels that ranged across the Atlantic to Canada for cod. If these ports don't look quite the same half a millennium later, there are ongoing efforts to protect or restore the land and seascape between them. Bermeo is now a gateway to the vast Urdaibai Biosphere Reserve.

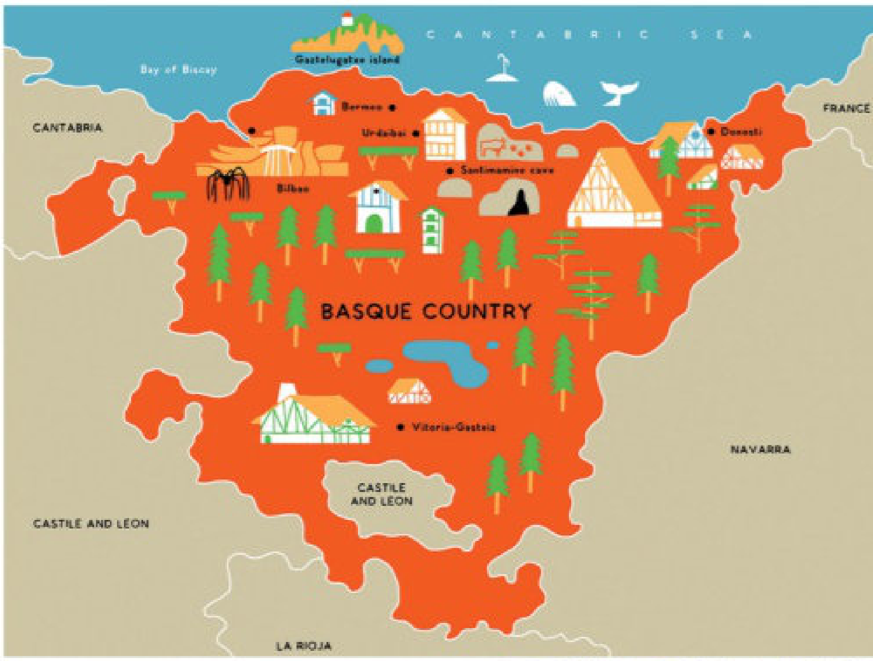
> **Ancestral voices tend to claim that the lamia retreated from this area as Christianity spread through it, their ears sensitive to echoes of chapel bells in the wilderness.**



That same sound brought fisherfolk luck and comfort. On summer feast days, processions of pilgrims from Bermeo, Bakio or Arrieta cross the long stone bridge to San Juan de Gaztelugatxe, climb the 241 steps (one step is said to be imprinted with the footprint of John the Baptist himself), and ring the church bell at the top three times. Ringing the bell is said to bring good luck and protect against evil, especially for those brave souls who work at sea.

A certain cheerful paganism persists, though, especially at carnival time in neighbouring Mundaka. In February, the men of the village dress as atorras, in white lace-embroidered sheets and pillowcases inspired by the saucy legend of an adulterer's makeshift disguise. The women, meanwhile, become lamiak: spectral figures in black dresses, white wigs, and two-tone makeup.

The surfing at Mundaka is world-class, or you can charter a boat, sail past the break, and out into the Bay of Biscay. There you can fish for sea bass or tuna on the silvery trails that Basque mariners have followed offshore for centuries.



Middle: A team of carpenters build traditional boats in Albaola shipyard, Basque Country. **Bottom:** San Juan Gaztelugatxe Hermitage, Bay of Biscay, Basque Country. ***Map by:*** *Guillermo Trapiello.*

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Adventures in the land of giants

City of Toledo, Castilla-La Mancha.

Across the Spanish interior, local folk traditions and regional cuisines attest to a rich and diverse cultural history.

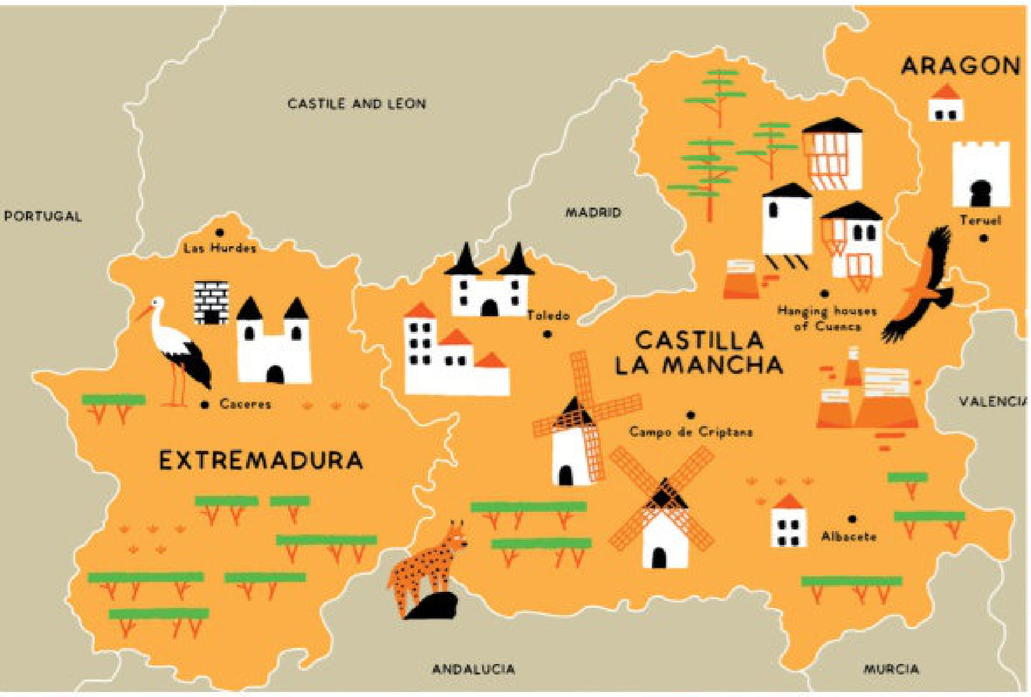
There are stretches of Spain's meseta central, or inner tableland, where anything that stands taller than a man on a horse can seem to loom gigantically over the plain. This helps to explain how the windmills of La Mancha were mistaken for giants by the fictional, delusional 'knight' Don Quixote.

His creator, Miguel de Cervantes, cast into prose the landscape that continues to give mythic impressions of Spain's interior. Among the most evocative are the windmills of Campo de Criptana, their white-painted towers now housing museums of sculpture, poetry, and wine. Here is a kind of oasis through the warmest months, supporting resident and seasonal populations of flamingoes, cranes, cormorants and turtles.

There is a dreamlike effect to approaching the cities of the hinterland. Cuenca, for example, was built by the Moors as an impregnable fortress on a limestone precipice high above a river gorge, and its casas colgadas, or 'hanging houses,' have leaned out over the void for close to a millennium.

The provincial capital, Toledo, rises like a layer cake of different architectural periods. Roman foundations lie beneath Visigoth temples, Islamic minarets and battlements blend into the Judeo-Mudejar designs of the Jewish Quarter, and an upper tier of spires is dominated by the soaring bell tower of Toledo Cathedral.

Across the meseta, in the former kingdom of Aragon, the skyline of Zaragoza appears reflected on the River Ebro as an otherworldly cross-section of Spanish history. The dazzlingly tiled and domed Basilica of Nuestra Señora de Pilar marks the spot where some believe the Virgin Mary appeared


ARAGON
CASTILE AND LEON
PORTUGAL
MADRID
Teruel
Las Hurdes
Toledo
Hanging houses of Cuenca
CASTILLA LA MANCHA
VALENCIA
Caceres
EXTREMADURA
Campo de Criptana
Albacete
ANDALUCIA
MURCIA

Top right: Windmill at Campo de Criptana, Castilla-La Mancha. **Bottom left:** 'Hanging houses,' Cuenca, Castilla-La Mancha. **Bottom right:** La Ciudad Encantada, a geological site near Cuenca, Castilla-La Mancha. ***Map by:*** *Guillermo Trapiello.*

to the apostle James in AD 40, while the Aljaferia Palace stands as a medieval Islamic wonder-structure constructed for the city's ruling Hudid dynasty.

> **Out beyond city limits, a dry wind known as the cierzo sweeps over plains that look like backdrops to phantasmic paintings by Francisco de Goya—whose art drew heavily on folk traditions and superstitions.**

Out beyond city limits, a dry wind known as the cierzo sweeps over plains that look like backdrops to phantasmic paintings by Francisco de Goya, whose art drew heavily on folk traditions and superstition. On the other side of the tableland in Extremadura, that sheer richness of myth has left the mountain hamlets of Las Hurdes with as many imaginary beings as living people. Hairy giant Pelujancanu, he-goat Machu Lanú, and Entihnaol the rain-bringer all join the annual parade of atavistic weirdness that is the Hurdano Carnival. The agricultural cycles they venerate have in turn grown ingredients for the recipes of multiple resident cultures to give this region its reputation for gastronomy.

Today's adventurer can even explore the grassy, hilly domain of the black Iberian pig on horseback gastro-tours, meeting and eating with Jamón producers on their farms, questing like a hungry Don Quixote.

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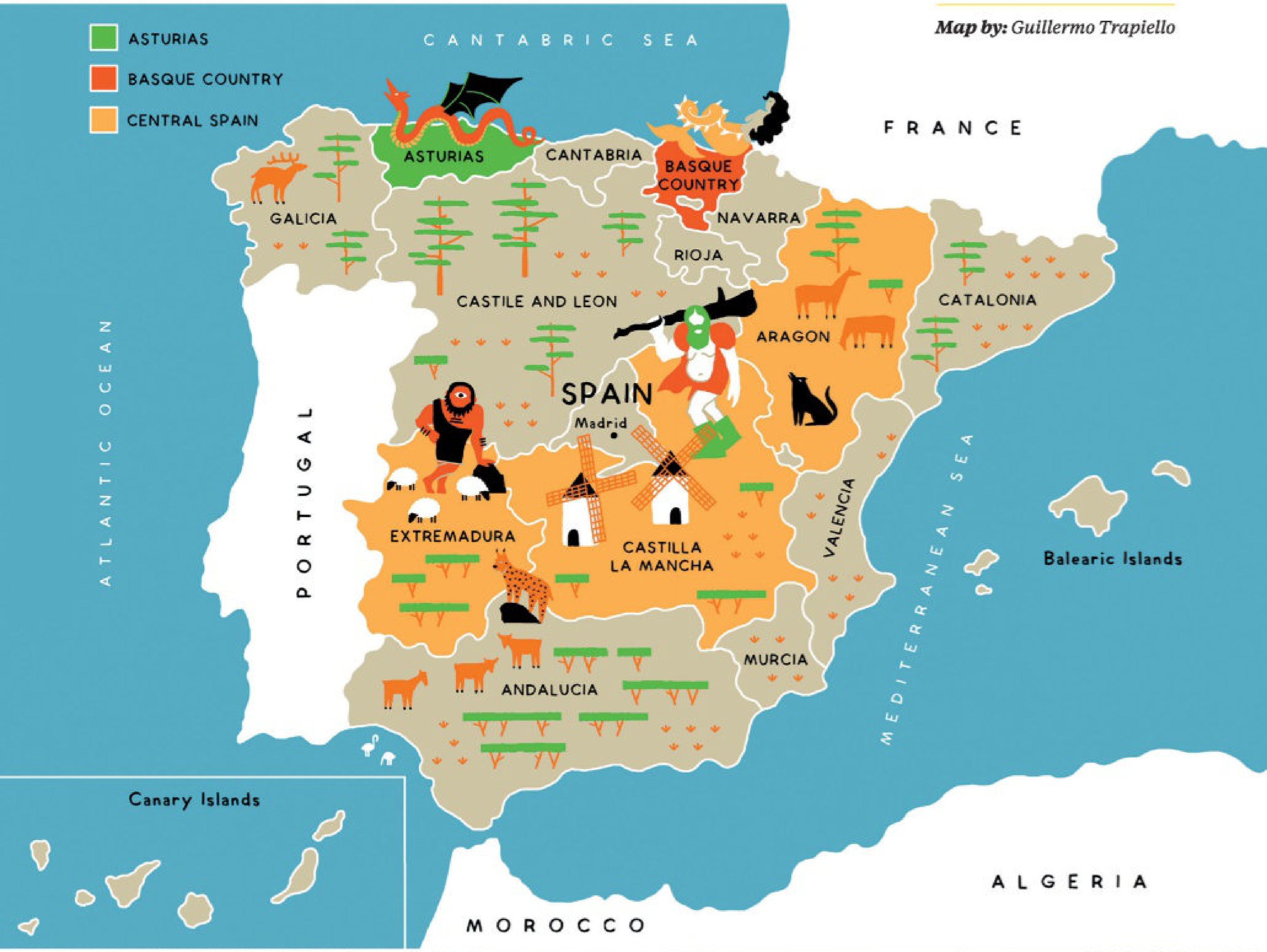
🟩 ASTURIAS
🟥 BASQUE COUNTRY
🟧 CENTRAL SPAIN
CANTABRIC SEA
FRANCE
ASTURIAS
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BASQUE COUNTRY
NAVARRA
RIOJA
GALICIA
CASTILE AND LEON
ARAGON
CATALONIA
SPAIN
Madrid
ATLANTIC OCEAN
PORTUGAL
EXTREMADURA
CASTILLA LA MANCHA
VALENCIA
MEDITERRANEAN SEA
Balearic Islands
MURCIA
ANDALUCIA
Canary Islands
ALGERIA
MOROCCO

Map by: *Guillermo Trapiello*

Left: Caves near the village of Elantxobe, Basque Country. **Right:** Toledo Cathedral, Toledo, Castilla-La Mancha.

Use this QR code to delve further into the mythical world of Spain.

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EXPLORE

IN THIS SECTION
Podcasts With Purpose
Explorer Bertie Gregory
Thawed Frog Chorus
Gateway to Hell

ILLUMINATING THE MYSTERIES—AND WONDERS—ALL AROUND US EVERY DAY
NATIONAL GEOGRAPHIC | VOL. 242 NO. 4

Live Longer by Living Younger

IF WE MAKE HEALTHY LIFESTYLE CHOICES, WE CAN SELF-ENGINEER GENETIC CHANGES TO PREVENT DISEASE AND BOOST LONGEVITY.

BY **MICHAEL F. ROIZEN, M.D.**

T

TAKE A MOMENT to visualize your favorite place in the world that requires you to walk up an incline. Maybe it's the Spanish Steps in Rome or the Potala Palace in Tibet. Or maybe it's a serene hill in your local park. Or the top row of your favorite team's stadium.

Now imagine that you've reached the summit. Take a look down at the other folks trekking toward you. You will see two kinds of people.

First, there's the spry set. These are the bouncy beings that kangaroo from the bottom to the top. They're smiling, laughing, barely breaking a sweat, and fully enjoying the journey. They're excited about reaching the destination and—despite the fact that it takes some effort—can't wait to experience what awaits when they arrive.

Second, there's the group that's struggling. Those who have to stop and catch their breath 10 times on the way up. Every. Step. Takes. So. Much. Out. Of. Them. Huff. Puff. Are. We. There. Yet?

YOU HAVE THE ABILITY TO CHANGE HOW YOUR BODY WORKS AND REACTS—AND ULTIMATELY HOW HEALTHY YOU ARE AND HOW LONG YOU MAY LIVE. YOU SHOULD BUILD A STRONG FOUNDATION NOW.

You're probably more like one of these groups than the other. What's the difference between them, besides their speed and the ease with which they travel? It might be their size or age, yes. It's most certainly their overall health.

But you know what it's less likely to be? Their genes endowed at birth. Instead, it's their lifestyle choices.

THE GREAT AGE REBOOT is the name my coauthors—Peter Linneman and Albert Ratner—and I gave our new book, published by National Geographic. The "great age reboot" is also our term for the transformation we see dawning: breakthroughs in health and medicine that will let us live longer and live younger; advances that will exponentially change our society, our economy, and our future.

To prepare for the great age reboot, you have to be willing to change—not only to get and stay healthy but also to have enough health to repair yourself when repairs are needed. There is certainly a fantastic future ahead. But to enjoy it and relish your longevity, you will need to be a genetic engineer now. The upside? You will literally get to change your family medical destiny—if you want to.

IN THE UNITED STATES about 40 percent of premature deaths—defined as occurring before age 75—are related to lifestyle choices, behaviors we can change. Lifestyle and genetics are intertwined, in that your lifestyle choices influence the ways that many of your genes function—and thus how your body functions.

Studies of human gene expression show that if you choose to make certain lifestyle changes, you can influence whether your genes are "on" or "off." In fact, your choices can influence an estimated 1,200 of the 1,500 genes that are on and probably can influence the other estimated 21,000 that are off.

For example, after implementing changes to their physical activity, stress management, and diet regimens, men were able to turn off genes associated with prostate cancer growth and turn on a gene that produced a protein that causes cancer cells to self-destruct. The same principle applies for colon and breast cancer: Lifestyle changes switched on genes that fought cancer and turned off genes that promoted it.

Science tells us that by the time you are about 60 years old, 75 percent of your health outcomes are determined by your choices. That's genetic self-engineering: Each healthy act switches on youth-promoting genes and switches off genes that cause you to age. This process is the result of millions of years of evolution. Good choices (and the proteins that are developed because of them) beget more good proteins, and the activation of bad genes begets more bad and destructive genes being turned on.

You have the ability to change how your body works and reacts—and ultimately how healthy you are and how long you may live. We'll give you three main reasons your pursuit of optimum health and youth through lifestyle choices is an imperative.

You should build a strong foundation now. You probably know people who've survived a horrific disease, accident, or surgery—and it was said that their preexisting physical and mental strength fortified their bodies for battle and made them better equipped to endure stresses. That's true with the recent COVID-19 pandemic: Over 80 percent of COVID-19 deaths were among people older than 65, and severe cases are more likely for those with preexisting conditions, such as obesity, diabetes, heart disease, chronic lung disease, and immune dysfunction.

The same thinking will apply when we're talking about longevity—that is, healthy choices will help prevent chronic disease and set you up for a long life. The better your physical shape, the higher the chances that new antiaging procedures will "take" at a high level, with fewer complications. Stronger at the start means stronger throughout the entire race and all the way to the finish.

It's unclear how many reboots you'll get. Perhaps in a utopian 25th-century world, there will exist some dressing-room-like catacomb that allows you to walk into a booth, press a few buttons, and erase every cigarette you've smoked, every couch you've potatoed, every potato you've ever fried. But for the foreseeable future, it's far more likely that your reboot chances will be limited. Your ability to maximize their effectiveness will depend on your commitment to improving your biology through proven means: nutrition, physical activity, sleep, not smoking, and stress management.

No matter what happens, your brain needs you. The human brain remains the final biological frontier. So even if science ultimately allows us to correct our cells, genes, and other mechanisms that make our bodies work, when your brain goes, you will too. To maximize the promise of a longer-lasting youth, it's imperative that you self-engineer your DNA switches

ILLUSTRATION: DAVID PLUNKERT

to protect your brain—and the steps are the same as those you can take to protect the rest of your body.

THE ACTIONS OUTLINED BELOW have been shown to have the most influence over your biological function. You're not going to behave perfectly all the time. Your longevity depends more on the aggregate of what you do most of the time. How can we collectively get to better decisions?

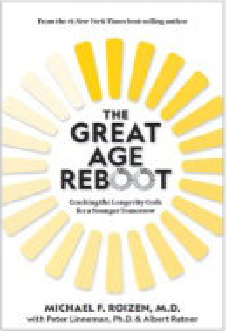
We are in a peak period for access to information and have the most medically advanced health industry of all time. Yet two-thirds of Americans are overweight or obese, and millions will die or become ill from choice-related health problems, including heart disease, lung cancer, stroke, diabetes, and dementia (yes, the data show that healthy lifestyles are associated with a 60 percent reduction in the risk of developing dementia).

Finding the right way to motivate ourselves to make better lifestyle choices is not easy, and we Americans have very effectively exported our bad habits to almost every other developed country. However, we do have some data about what has worked. Several factors are common among people who successfully make positive lifestyle changes:

They achieve "normals"—our term for satisfactory health metrics or health and wellness behaviors—on six indicators.* The healthiest bodies are the ones that meet the goals set by the six key indicators listed at the bottom of this page. That's why our barometer for health success is "6 Normals + 2"—normal scores on those six indicators plus two other factors: seeing a primary care physician and ensuring your immunizations are up-to-date.

They use technology. The marketplace is full of all kinds of trackers that provide real-time feedback about our health choices. You can track steps, minutes of activity, heart rate, calories, sleep quality, and much more. While not everyone needs or likes these aids, technology can provide an excellent form of motivation by establishing benchmarks and goals. And it can help you try to reach those goals, especially when combined with the encouragement of a coach. The human touch is key to making the technology meaningful and the changes sustained.

They leverage financial incentives. It's a basic human reaction: Significant financial incentives have always been a driver of behavior change. Much of the burden of establishing those incentives comes down to how our government and industries reward employees who stay or get healthy. You can improve your financial situation with better health, starting with lower medical costs, higher work productivity, a longer career, and less worry about the impacts of pandemic diseases too.


From the #1 New York Times best-selling author
THE GREAT AGE REBOOT
Cracking the Longevity Code for a Younger Tomorrow
MICHAEL F. ROIZEN, M.D.
with Peter Linneman, Ph.D. & Albert Ratner

'Rebooting' Your Youth

Science and technology will revolutionize our ability to live longer, younger, and better. So says *The Great Age Reboot: Cracking the Longevity Code for a Younger Tomorrow,* written by Michael Roizen with Peter Linneman and Albert Ratner. Published in September by National Geographic, it is available where books are sold.

They have a buddy, or several. You need a built-in ecosystem with your own tribe—a community of people who support one another in pursuit of their goals. It can come in many forms: one person, a small group of people, or a large tribe with lots of people pursuing the same goals. Many of us may experience some combination of those supporters during the evolution of a wellness journey. Having a partner (or partners) in your pursuit of behavior change is the variable that most predicts success.

They do the little things that matter. Going into a hip replacement at age 59 and again at 64, coauthor Peter Linneman was fit, did physical therapy before the surgery, and actively stuck with it after surgery; as a result, he was able to quickly and fully recover. Peter's physical therapist noted that the scenario for most patients is to go into the surgery weak and ignore the post-op therapy. They blow it off, perhaps thinking it's really not that important. This is the way a lot of us think about health: Why bother with the little things? Will they really matter that much? Yes! Every little decision adds up, and even more as you live longer.

Science is about to offer you the Garden of Eden. A chance not just at prolonged life but at prolonged youth—or rather, and even better, prolonged youthful years.

But taking advantage of it will be up to you.

Michael Roizen, M.D., is the chief wellness officer emeritus at the Cleveland Clinic, a professor at the Cleveland Clinic Lerner College of Medicine at Case Western Reserve University, and author of four number one *New York Times* best-selling books.

*Six indicators of good health

Six key indicators of the optimal health status that promotes longevity:

- **Blood pressure** of less than 120 mmHg systolic and less than 80 mmHg diastolic
- **BMI** (a measurement of height-to-weight ratio) of less than 27 or, better, a waist-to-height ratio of 0.40 to 0.55
- **LDL cholesterol** (a risk factor for heart disease) of less than 70 mg/dL
- **Fasting blood sugar** (associated with diabetes) of less than 106 mg/dL
- **Urine free of cotinine** (an indicator of tobacco use)
- Completion of a **stress management** program

JAMES CAMERON PRESENTS

NATIONAL GEOGRAPHIC

SUPER NATURAL

NARRATED BY
BENEDICT CUMBERBATCH

IF YOU THINK YOU KNOW NATURE,
THINK AGAIN

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INNOVATOR

CATHERINE DE MEDICI JAFFEE

BY **JORDAN SALAMA**

PHOTOGRAPH BY **BENJAMIN RASMUSSEN**

She produces podcasts at the crossroads of science and social justice.

Catherine de Medici Jaffee has always been surrounded by storytellers. The first was her father—a literature-loving rancher with a radio show who, even when terminally ill, led their family on global travels. Following in that adventurous spirit, Jaffee spent time in India and Japan, learning how well-told tales can advance religious, political, and social change.

She then turned storytelling into a career and at first considered creating documentaries. But something felt off, she says: “The camera would come out, and the people stopped smiling.” Jaffee wondered whether her subjects would feel more comfortable speaking into a microphone than being filmed.

Her solution: podcasts, both less intimidating and more accessible. In 2017 she founded House of Pod, a nonprofit that helps would-be podcasters tell stories centered on their communities, which often lack a voice. A National Geographic Explorer, Jaffee recently worked with Angolan biologist and environmental anthropologist Kerllen Costa on *Guardians of the River,* part of the National Geographic Society’s Okavango Wilderness Project, which surveys and seeks to protect the biodiverse river basin in southwestern Africa. In 2021 *Guardians of the River* won the Tribeca Festival’s Podcast Non-Fiction Award.

Another virtue of podcasts, Jaffee says, is that “audio moves with you.” She has many more stories on the way.

The National Geographic Society has funded the work of audio storytelling specialist Catherine de Medici Jaffee since 2012. Learn more about its support of Explorers at *natgeo.com/impact*.

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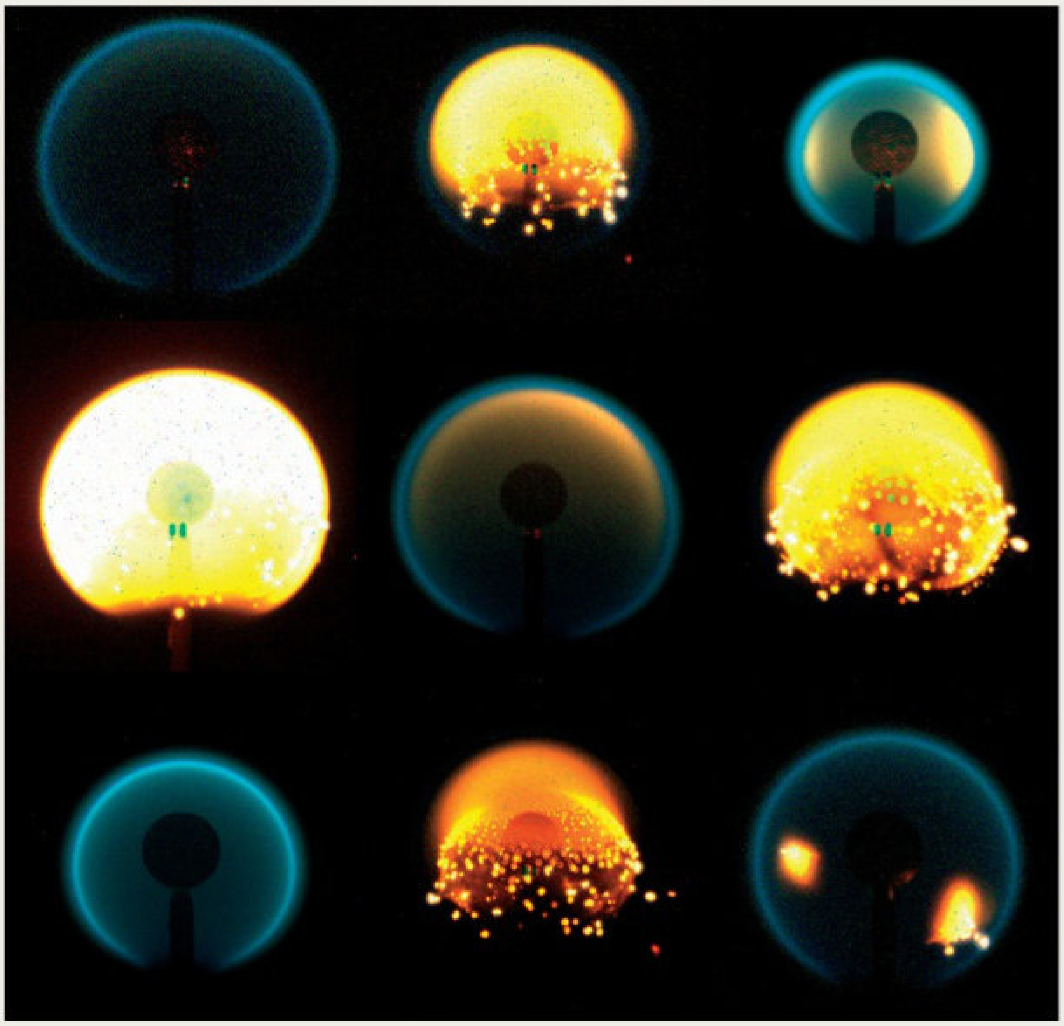
DISPATCHES
FROM THE FRONT LINES
OF SCIENCE
AND INNOVATION

Climate change smacks tomatoes

Pizza sauce, pasta sauce, ketchup: Tomatoes star in many everyday foods. But in recent years, drought and extreme heat have blistered California, which grows about 30 percent of Earth's processing tomatoes—hitting the crop hard and putting farmers and pizza lovers alike in a bind. —ALEJANDRA BORUNDA



SPACE RESEARCH

COSMIC COMBUSTION

ON THE SPACE STATION, THE ABSENCE OF GRAVITY MAKES FLAMES BEHAVE IN 'OTHERWORLDLY' WAYS.

On Earth, we know flames as flickering tongues—but in space, that changes. Without gravity, hot air lacks the buoyancy to whip flames into their familiar, dancing forms. In microgravity they can swell into ethereal domes and orbs that can burn at a surprisingly cool 900 degrees Fahrenheit (a gas stove burner's high setting is about 3100°F). The flames in the image above burned aboard the International Space Station, as part of ACME (short for Advanced Combustion via Microgravity Experiments). "I've had science fiction writers contact me about the flames," says the University of Maryland's Peter Sunderland, an ACME investigator. "They *are* otherworldly." For more than four years on the station, ACME ignited over 1,500 flames, in tests aimed at improving spacecraft fire safety and computer models of combustion. And none too soon: Combustion of fossil fuels remains a massive source of carbon emissions and air pollution. —MICHAEL GRESHKO

BIODIVERSITY

Blue macaw back from the brink

More than 20 years after it was declared extinct in the wild in Brazil, the Spix's macaw is being reintroduced there. Habitat loss and poaching had decimated the blue-feathered species, last seen in the wild in 2000. Enter collectors who owned a handful of the birds, and conservationists who helped set up a captive-breeding program in Brazil. In June, eight macaws were set free in protected forest, with a dozen more birds to follow at year's end. —ANNIE ROTH

IMAGES: NASA (GRID OF NINE IMAGES); AC BNPHOTOS/GETTY IMAGES (TOMATO); ASSOCIATION FOR THE CONSERVATION OF THREATENED PARROTS (MACAW)

FROM THE STUDIO THAT BROUGHT YOU
FROZEN AND ENCANTO

Disney

STRANGE WORLD

DISCOVER THE IMPOSSIBILITIES

IN CINEMAS
NOVEMBER

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A SURREAL SPAN

In Pakistan's northern region of Gilgit-Baltistan, humanity and its endeavors

STRETCHING OVER THE GLACIER-FED waters of the Hunza River and linking the rugged faces of the Karakoram Range, the Hussaini Hanging Bridge appears to be no more than a delicate thread. Indeed, when the wind blows, the entire length of rope and wooden planks begins to sway.

GETTING THE SHOT

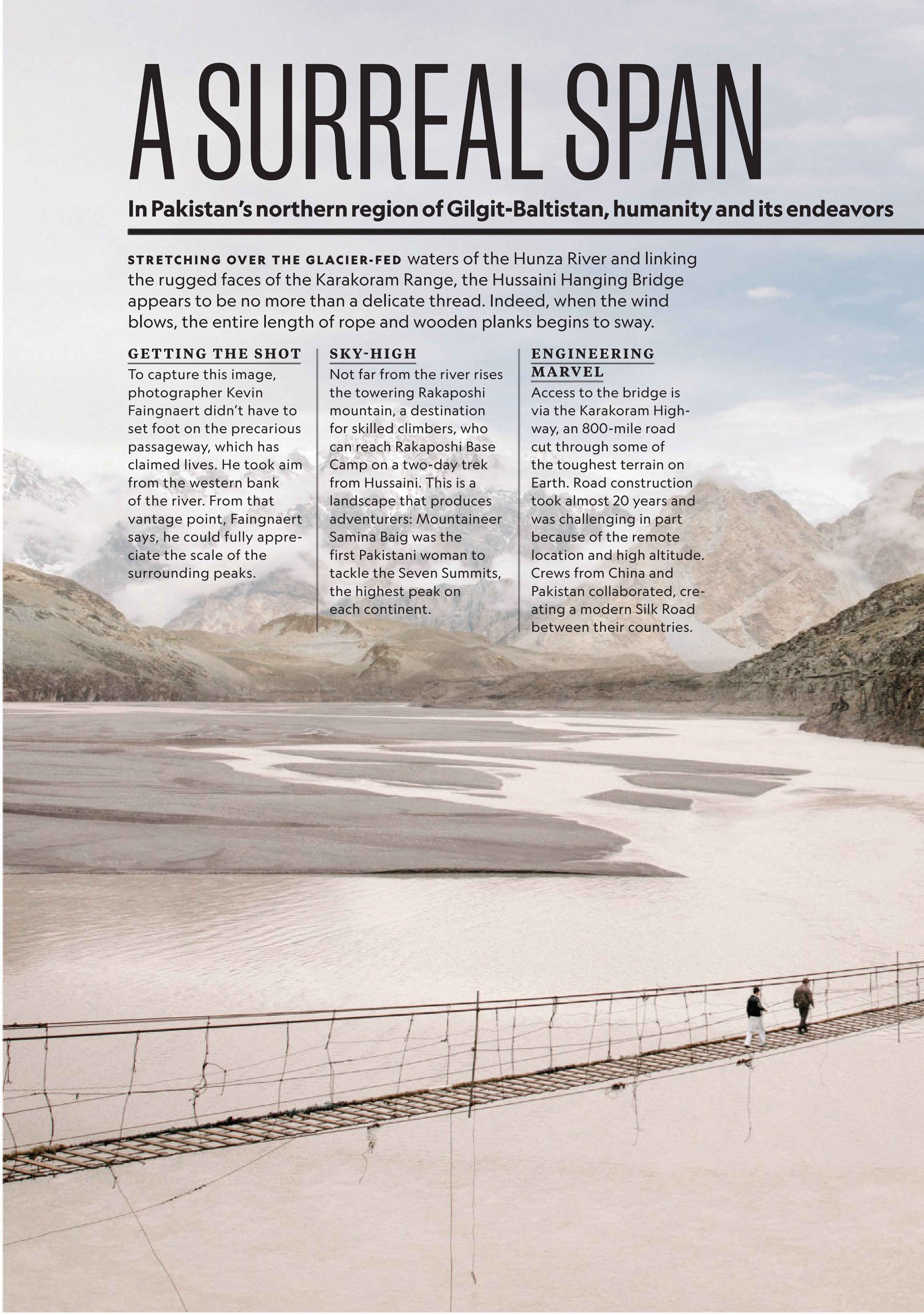
To capture this image, photographer Kevin Faingnaert didn't have to set foot on the precarious passageway, which has claimed lives. He took aim from the western bank of the river. From that vantage point, Faingnaert says, he could fully appreciate the scale of the surrounding peaks.

SKY-HIGH

Not far from the river rises the towering Rakaposhi mountain, a destination for skilled climbers, who can reach Rakaposhi Base Camp on a two-day trek from Hussaini. This is a landscape that produces adventurers: Mountaineer Samina Baig was the first Pakistani woman to tackle the Seven Summits, the highest peak on each continent.

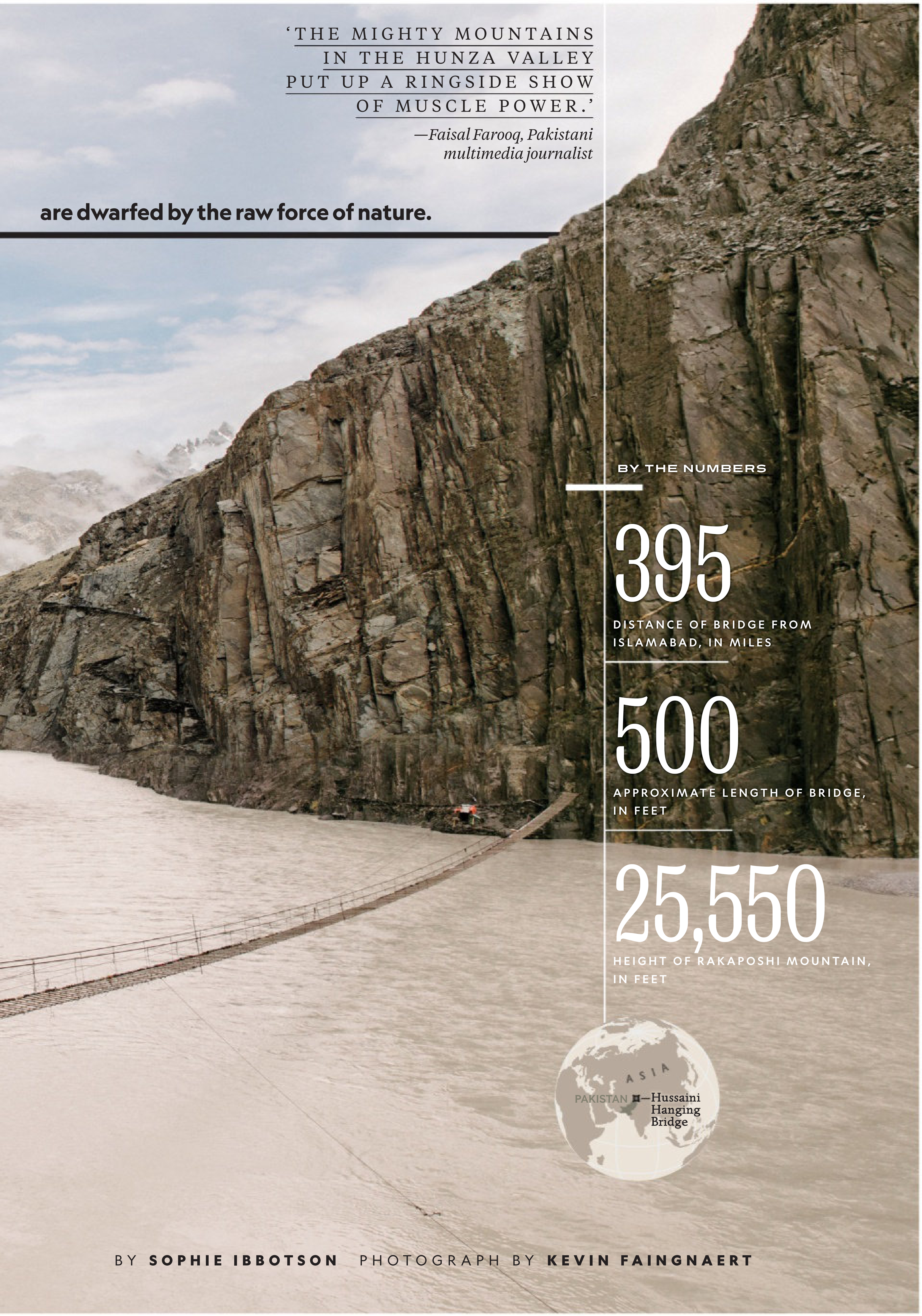
ENGINEERING MARVEL

Access to the bridge is via the Karakoram Highway, an 800-mile road cut through some of the toughest terrain on Earth. Road construction took almost 20 years and was challenging in part because of the remote location and high altitude. Crews from China and Pakistan collaborated, creating a modern Silk Road between their countries.



are dwarfed by the raw force of nature.

> ‘THE MIGHTY MOUNTAINS IN THE HUNZA VALLEY PUT UP A RINGSIDE SHOW OF MUSCLE POWER.’
>
> *—Faisal Farooq, Pakistani multimedia journalist*



BY THE NUMBERS

395

DISTANCE OF BRIDGE FROM ISLAMABAD, IN MILES

500

APPROXIMATE LENGTH OF BRIDGE, IN FEET

25,550

HEIGHT OF RAKAPOSHI MOUNTAIN, IN FEET

BY **SOPHIE IBBOTSON** PHOTOGRAPH BY **KEVIN FAINGNAERT**

SHARING HIS PASSION FOR WILDLIFE CONSERVATION

Filmmaker Bertie Gregory emerges camera-first through a huge swarm of mackerel.

BERTIE GREGORY HAS COME a long way from the Reading, England, backyard where, as a youngster, he snapped photos of birds and badgers. Today he's a natural history filmmaker and National Geographic Explorer who has visited every continent, documenting some of the most epic, least seen wildlife spectacles on Earth. Along the way, the 29-year-old has crossed paths with crocodiles and jaguars, logged thousands of hours in jungles and deserts, and lured beluga whales into camera range by singing to them (pop star Adele's tunes work well, he found). As a boy, Gregory was teased for being "totally obsessed with the natural world," he notes. But that zeal led to this career—and, he says, it's "a great way to get other people excited" about conserving wildlife. In his new series, *Epic Adventures With Bertie Gregory,* he takes viewers behind the camera to see both amazing animals and all the work and luck that go into filming them. Each episode tries to show the best of "animal and human, epic and personal, beautiful and urgent," Gregory says. "I hope audiences are going to be blown away." —ANNIE ROTH

From National Geographic, all episodes of the five-part original series *Epic Adventures With Bertie Gregory* are now streaming on Disney+.

PHOTO: NATIONAL GEOGRAPHIC FOR DISNEY+

THESE FROGS MELT WHEN MATING SEASON STARTS

PHOTOGRAPH BY **JOEL SARTORE**

DURING WINTERS IN NORTH AMERICA, many amphibians dive or burrow deep to avoid freezing—but not the wood frog. These fig-size croakers stay put aboveground as the water between their cells freezes, and they spend the season in a kind of cryosleep.

When spring arrives, most wood frogs awaken from their icy slumber with one thing on their mind: sex. Males find a pond or temporary vernal pool and call to females with sounds "almost like a quacking duck," says Dartmouth College's Ryan Calsbeek, a biology professor who studies amphibians' sex lives. As more males join in, the cacophony of croaks can be heard throughout the forest.

Hearing the come-ons from the ponds around them, females hop toward the croaks they find most seductive. In a recent study using an advanced acoustic camera (see QR code at right), Calsbeek determined that female wood frogs, like many humans, can't resist deep, husky voices. Such croaks tend to come from large frogs—but once a female is lured to a pond, she's fair game for all its male frogs, including small sopranos. The victor is the male that grasps and mounts the female, wrapping his forelimbs around her torso, a position known as amplexus. He squeezes until she deposits her eggs into the water; he then releases sperm, fertilizing the eggs.

It's female wood frogs' fate to have several breeding opportunities during their two-to-three-year life span. So odds are good that they'll find at least one big baritone daddy. —ANNIE ROTH

RANGE/HABITAT

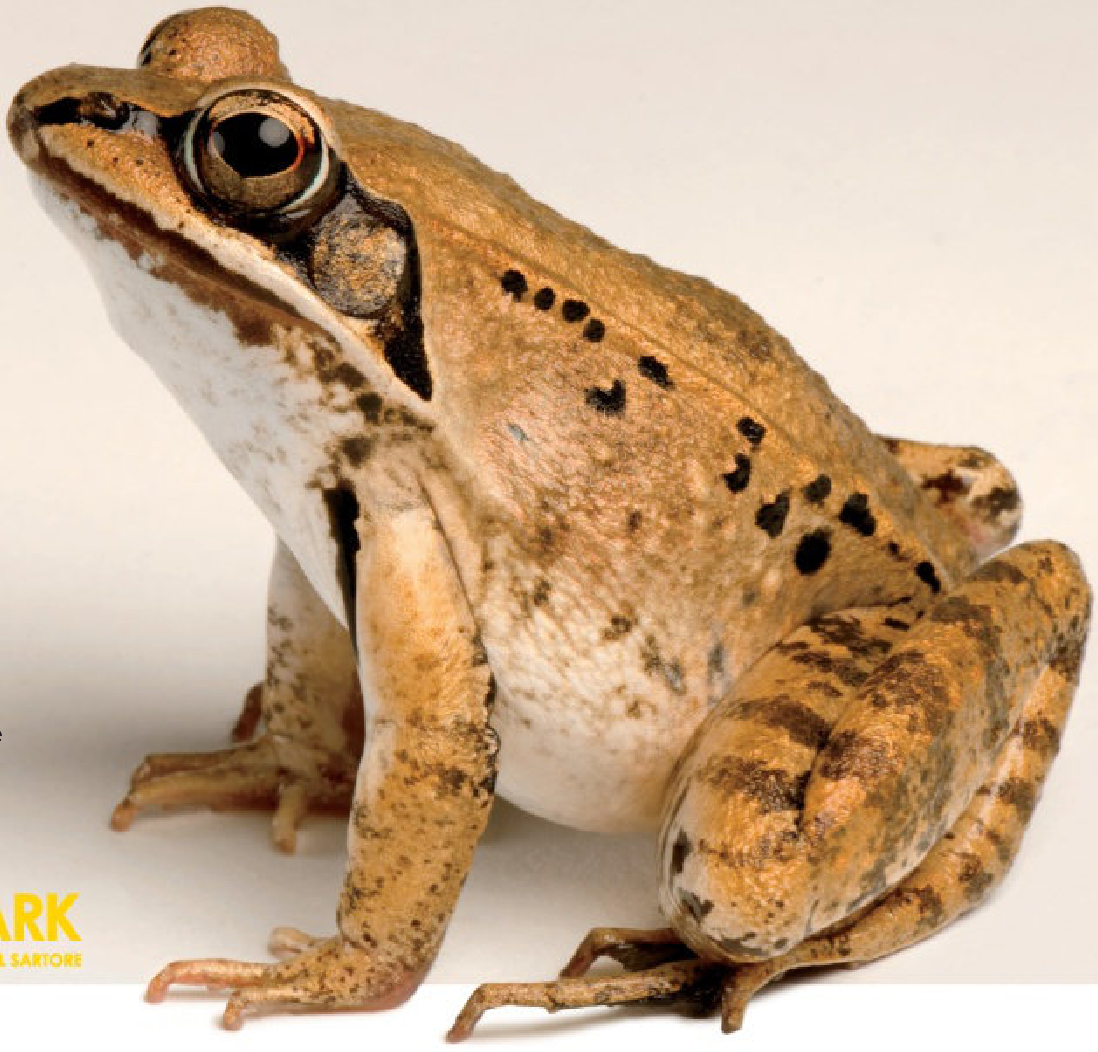
Lithobates sylvaticus are the only amphibians found north of the Arctic Circle. In Canada, as well as Alaska and other parts of the United States, they live in tundra, grassland, and forest habitats.

OTHER FACTS

Wood frogs' bodies produce a sort of natural antifreeze that prevents their cells from bursting as they ice over during the winter.

The thumbs of males swell during breeding to help them hold on to females.

Scan this code with your smartphone to see and hear an acoustic camera video of male frogs croaking to court females.

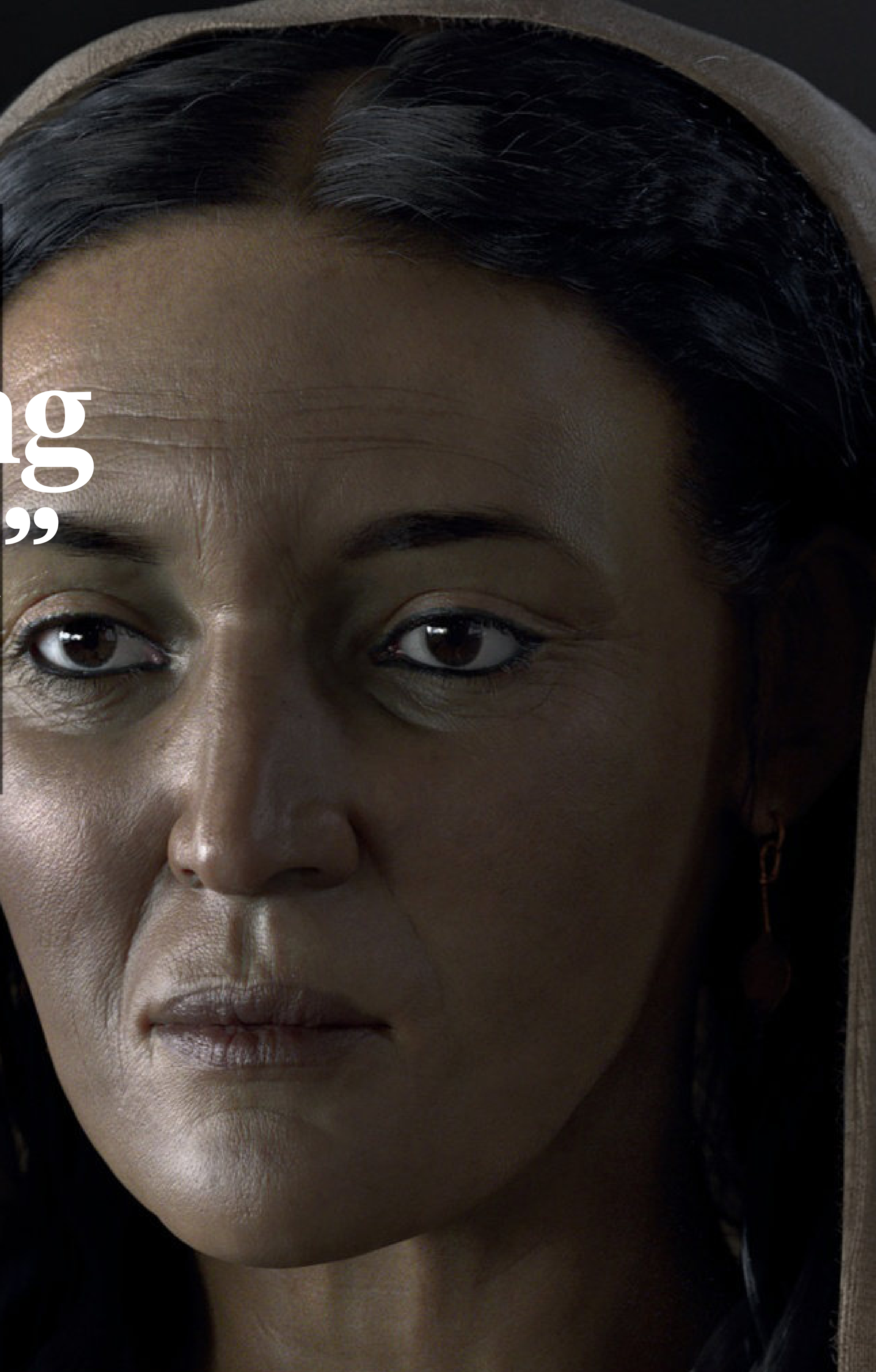


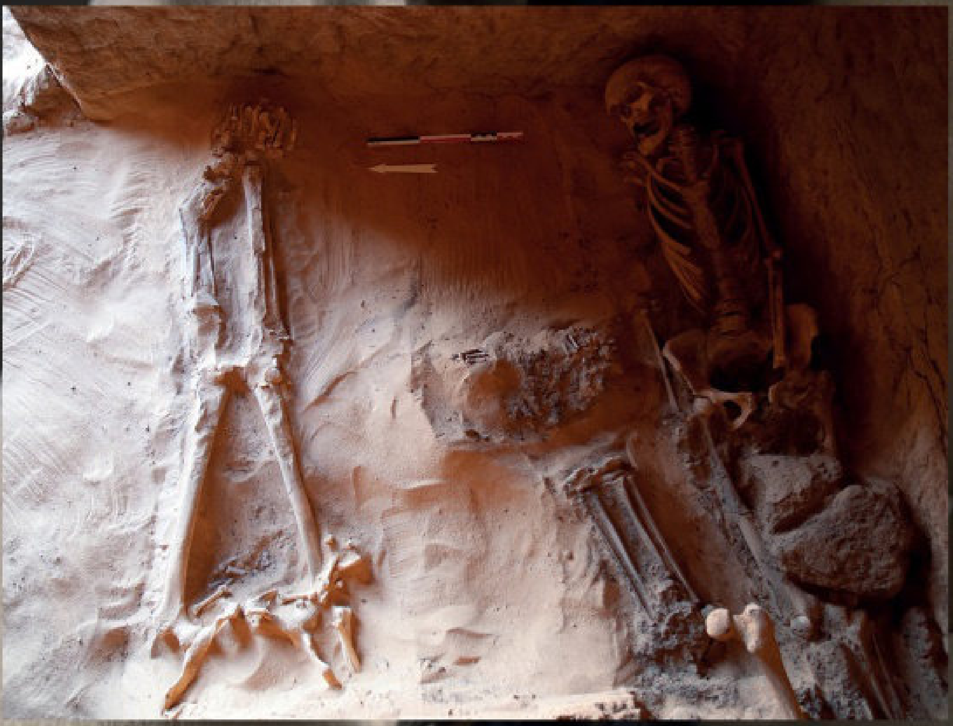
This wood frog was photographed at the National Aquarium in Baltimore.

NATIONAL GEOGRAPHIC PHOTO ARK JOEL SARTORE

Meeting “Hinat”

In the deserts of northwest Arabia, a short way from the majestic AlUla valley, lies the ancient city of Hegra. Once an important trading hub for the Nabataean people, Hegra has become the focus for a groundbreaking project bridging science and art to bring us face to face with a Nabataean woman for the first time.





Main picture: After much collaboration and the combination of many different areas of expertise, the team of scientists finally had a 2,000-year-old visage staring back at them. *Credit: ©ADAGP Paris 2022 Philippe Froesch*

Left: A tomb at the ancient site of Hegra contained the remains of a female affectionately named “Hinat” after an inscription on the tomb’s exterior—her facial reconstruction could help to give experts insight into her long-lost culture. *Credit: Madâin Sâlih Archaeological Project (CNRS-Heritage Commission).*

By the late fourth century BCE, the Nabataeans, a tribe most likely from Arabia who had established themselves at what is now Petra in modern Jordan, were becoming wealthy from trade in frankincense, spices, and other luxury goods. As their kingdom expanded, they founded new centers of trade and culture, settling in Hegra—roughly 300 miles, or 500km, south of Petra—in the first century BCE. Their unique civilization blended elements of diverse cultures, fueled by wealth from their role in trading valuable commodities, and they carved fabulously elaborate tombs into the sandstone cliffs that surround Hegra.

Two thousand years later, archaeologists investigating the tombs carved into Jabal Ahmar, a mountainous outcrop on the edge of the residential area of Hegra, selected one for close study. Known as the Tomb of Hinat daughter of Wahbu, it was filled with unusually well preserved materials such as buried human remains—bones, skin and even hair—along with textiles, leather, vegetable matter, and other substances.

This tomb had another very special attraction, as Laïla Nehmé, the director of the Hegra archaeological project explains: “The Nabataeans are a bit of a mystery: we know a lot, but at the same time we know very little because they didn’t leave any literary texts or records. Excavating this tomb was a wonderful opportunity to learn more about their idea of the afterlife. Besides, this tomb has a very nice inscription carved on its façade, which says it belonged to a woman called Hinat.”

Who was Hinat? We don’t know for sure. But in 60 or 61 C.E., she had carved the following message onto a panel above the entrance to her tomb:

> **“This is the tomb which Hinat daughter of Wahbu made for herself and for her children and her descendants forever. And no-one has the right to sell it or give it in pledge or write for this tomb a lease. And whoever does other than this, his share will revert to his legitimate heir. In the twenty-first year of King Maliku, King of the Nabataeans.”**

Analysis of the tomb established that it was the final resting place of as many as 80 individuals. In one area, a wooden coffin held the remains of at least four people—one adult and three children.

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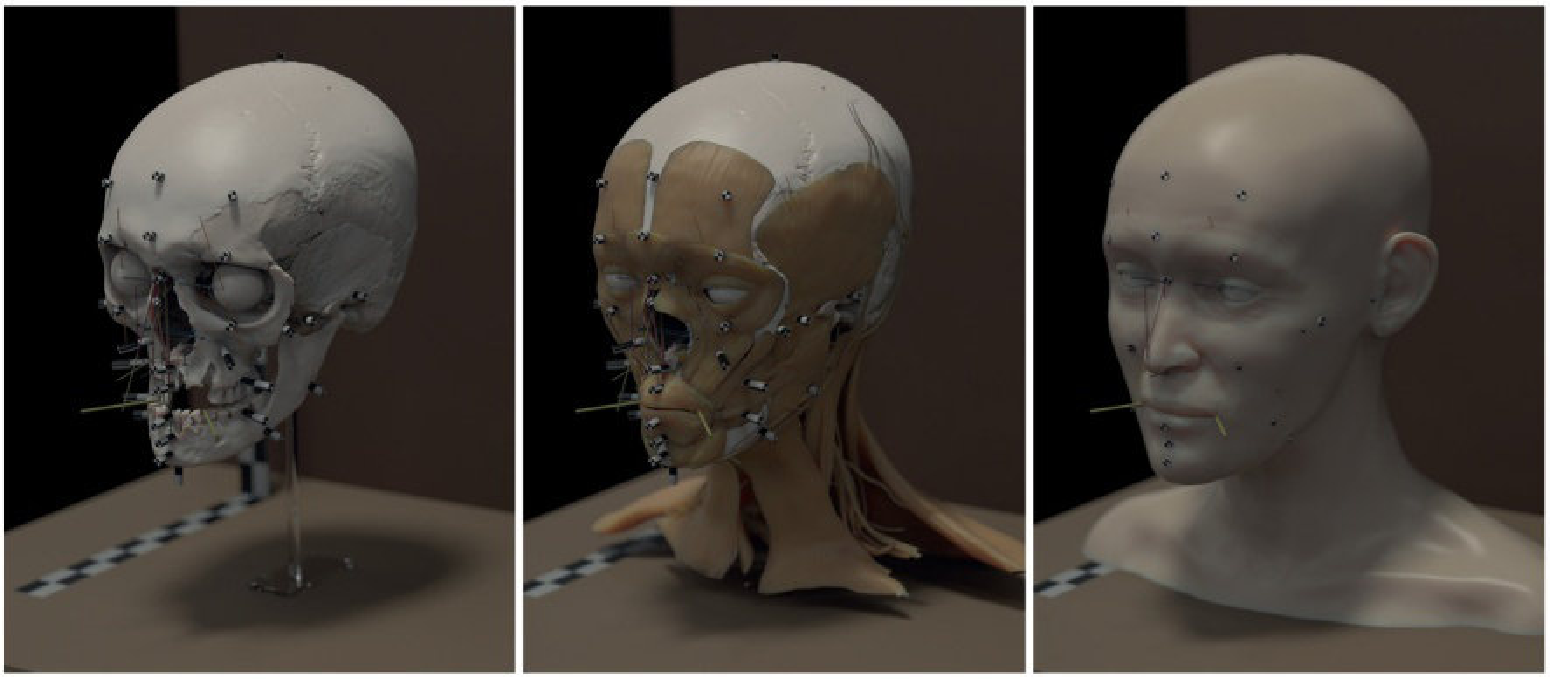


Above: Using the woman's skull, a team of specialists in facial reconstruction and forensics created a computer generated image of what she might have looked like. *Credit: ©ADAGP Paris 2022 Philippe Froesch.*

Elsewhere bones, fabric, and leather lay mixed up together with strings of desiccated dates, apparently created as necklaces.

Gathering as much information as possible from the materials unearthed in the tomb led to an intriguing idea. By analyzing one of the tomb's skulls, a question arose: Could we use existing knowledge in forensics and paleopathology (the study of disease in ancient people) to reconstruct the face of the person who died and was buried here? Such a reconstruction—the first ever attempted of someone from the Nabataean period—would have immense value in being able to tell the story of Hegra, and of Nabataean civilization, to a worldwide audience.

But who to choose? Analysis of one of the skeletons in the tomb revealed it was a woman, aged between 40 and 50, around 5 feet 3 inches tall (1.6m), and the nature of her burial suggested she was of medium social status. Taking a lead from the tomb's inscription, archaeologists affectionately named her Hinat, and she became the project's focus.

Then came a gathering of international experts in London to lay the groundwork for the reconstruction project—archaeologists of Nabataean civilization, specialists in digital and physical facial reconstruction, forensic experts, and science communicators—who would translate a computer-generated image into a physical bust of Hinat. With almost no images discovered in Nabataean art, and very few human remains surviving, the specialists had to use a carefully judged mix of professional rigour and artistic interpretation to make key decisions about Hinat's features—her eye-color, skin tone, how many wrinkles she had, what clothes she wore, and the style of any jewelery or ornaments.

Forensic sculptor Philippe Froesch talks about how every scrap of scientific knowledge was exhausted before artistry came into play: "We created a subjective portrait using [pre-existing] data," he says. Froesch's job was to produce an initial computer image of Hinat. To do so, he collaborated with forensic pathologist Philippe Charlier to refine details of her face. A computerized tomography (CT) scan of the skull revealed evidence of chronic osteoarthritis and even traces of infectious disease in the teeth, elements that needed to be taken into account when shaping Hinat's mouth. Froesch used technical data on facial musculature and skin thickness to reconstruct

Hinat's features in minute detail, carefully adjusting individual eyelashes and skin pores.

Sitting in front of his computer, Froesch remembers: "There is always a moment which is very touching, and it is when you open the eyelids of the subject. Suddenly you see the eyes of this person looking at you. It's a kind of dialogue that happens, a very intimate moment."

At that point, Froesch handed the baton to Ramón López, a biologist and sculptor specializing in creating naturalistic reproductions of humans and animals. López and his team used stereolithography—an industrial 3D printing technique deploying resins in individual layers—to create a series of moulds that eventually resulted in a bust of Hinat in silicon. Experts working with López attached Hinat's hair in individual strands, added makeup to her skin surface, attached earrings designed as replicas of jewelry discovered in Hegra, and clothed her in artisan woven linen to match fragments recovered from Hegra's tombs.

At last, after having lain undisturbed in the sands of Hegra for twenty centuries, Hinat—or a woman who may have known Hinat, probably as a member of her family—gazed back at the awe-struck scientists, the result of a months-long, scientifically rigorous, and artistically innovative process. Curatorial Manager and archaeologist Dr Helen McGauran identified the value of such a remarkable project for the 21st century. "There are common threads of humanity that can be recognised in the Nabataean story," she says. "The openness to the outside world [and] the interaction with other cultures and communities." Hinat's two-thousand-year-old face has a lot to teach us.

To learn more about AlUla visit www.nationalgeographic.com/journey-to-alula

To plan a trip to AlUla visit www.experiencealula.com

Above: Named after the region's iconic red hued sandstone, the outcrop of Jabal Ahmar in Hegra is home to around 18 tombs, including the tomb where the remains of "Hinat" were discovered. *Credit: Royal Commission for AlUla*

Into a Shadow Realm

ARCHAEOLOGISTS ARE DECODING IRELAND'S ANCIENT ROYAL SITE OF RATHCROGHAN—INCLUDING ITS MYSTERIOUS GATEWAY TO THE UNDERWORLD.

BY **RONAN O'CONNELL**

IN THE MIDDLE OF A FIELD in a lesser known part of Ireland is a large mound where sheep wander and graze freely. Had they been in that same location centuries ago, these animals might have been stiff with terror, held aloft by chanting, costumed celebrants while being sacrificed to demonic spirits that were said to inhabit nearby Oweynagat cave.

This monumental mound lay at the heart of Rathcroghan, the hub of the ancient Irish kingdom of Connaught. The former Iron Age center is now largely buried beneath the farmland of County Roscommon. Ireland is pushing for its inscription on the UNESCO World Heritage list.

Spread across more than two square miles, Rathcroghan encompasses 240 archaeological sites, dating back 5,500 years. They include burial mounds, ring forts (settlement sites), standing stones, linear earthworks, an Iron Age ritual sanctuary—and Oweynagat, the so-called gate to hell.

More than 2,000 years ago, when Ireland's communities seem to have worshipped nature and the land itself, it was here at Rathcroghan that the Irish New Year festival of Samhain (SOW-in) was born, says archaeologist and Rathcroghan expert Daniel Curley. In the 1800s, the Samhain tradition was brought by Irish immigrants to the United States, where it morphed into the sugar overload that is American Halloween.

Dorothy Ann Bray, a retired associate professor at McGill University and an expert in Irish folklore, explains that pre-Christian Irish divided each year into summer and winter. Within that framework were

Buried beneath the green fields of Ireland's County Roscommon, Rathcroghan dates back to 3500 B.C. and contains 240 archaeological sites, one a so-called cave to hell.

four festivities. Imbolc, on February 1, was a festival that coincided with lambing season. Bealtaine, on May 1, marked the end of winter and involved customs like washing one's face in dew, plucking the first blooming flowers, and dancing around a decorated tree. August 1 heralded Lughnasadh, a harvest festival dedicated to the god Lugh and presided over by Irish kings. Then on October 31 came Samhain, when one pastoral year ended and another began.

Rathcroghan was not a town, as Connaught had no proper urban centers and consisted of scattered rural properties. Instead, it was a royal settlement and a key venue for these festivals. During Samhain, Rathcroghan was a hive of activity focused on its elevated temple, which was surrounded by burial mounds for the Connachta elite.

Those same privileged people may have lived at Rathcroghan. The remaining, lower-class Connachta communities resided in dispersed farms and descended on the site only for festivals. At those lively events they traded, feasted, exchanged gifts, played games, arranged marriages, and announced declarations of war or peace.

Festivalgoers also may have made ritual offerings, possibly directed to the spirits of Ireland's otherworld. That murky, subterranean dimension, also known as Tír na nÓg (Teer-na-nohg), was inhabited by Ireland's immortals, as well as a myriad of beasts, demons, and monsters. During Samhain, some of these creatures escaped via Oweynagat cave.

"Samhain was when the invisible wall between the living world and the otherworld disappeared,"

PHOTO: JOE FENWICK, UNIVERSITY OF GALWAY

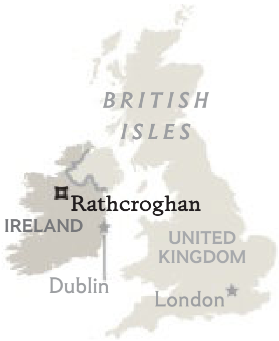
says Mike McCarthy, a Rathcroghan tour guide and researcher who has co-authored several publications on the site. “A whole host of fearsome otherworldly beasts emerged to ravage the surrounding landscape and make it ready for winter.”

Thankful for the agricultural efforts of these spirits but wary of falling victim to their fury, the people protected themselves from physical harm by lighting ritual fires on hilltops and in fields. They disguised themselves as fellow ghouls, McCarthy says, so as not to be dragged into the otherworld via the cave.

Despite these engaging legends—and the extensive archaeological site in which they dwell—one easily could drive past Rathcroghan and spot nothing but paddocks. Some experts say Rathcroghan may be Europe’s largest unexcavated royal complex. Not only has it never been dug up, but it also predates Ireland’s written history. That means scientists must piece together its tale using noninvasive technology and regional artifacts.

While Irish people for centuries knew this site was home to Rathcroghan, it wasn’t until the 1990s that a team of Irish researchers used remote sensing technology to reveal its archaeological secrets beneath the ground.

“The beauty of the approach to date at Rathcroghan is that so much has been uncovered without the destruction that comes with excavating upstanding earthwork monuments,” Curley says. “[Now] targeted excavation can be engaged with, which will answer our research questions while limiting the damage inherent with excavation.”



This policy of preserving Rathcroghan’s integrity and authenticity extends to tourism. Despite its significance, Rathcroghan is one of Ireland’s less frequented attractions, drawing some 22,000 visitors a year compared with more than a million at the Cliffs of Moher. “If Rathcroghan got a UNESCO listing and that attracted more attention here, that would be great, because it might result in more funding to look after the site,” Curley says. “But we want sustainable tourism, not a rush of gimmicky Halloween tourism.”

Those travelers who do seek out Rathcroghan might have trouble finding Oweynagat cave. Barely signposted, it’s hidden beneath trees in a paddock at the end of a one-way, dead-end farm track, about a thousand yards south of the much more accessible temple mound.

Visitors are free to hop a fence, walk through a field, and peer into the narrow passage of Oweynagat. In Ireland’s Iron Age, such behavior would have been enormously risky during Samhain, when even wearing a ghastly disguise might not have spared the wrath of a malevolent creature.

Two millennia later, most costumed trick-or-treaters on Halloween won’t realize they’re mimicking a prehistoric tradition—one with much higher stakes than the pursuit of candy. ▫

Ronan O’Connell is an Irish Australian journalist and photographer based in Perth.

Pre-Christian Irish considered Oweynagat an entrance to the underworld, inhabited by devils, fairies, and other supernatural beings. The cave is also the legendary birthplace of Medb, perhaps the most famous queen in Irish history, 2,000 years ago.

PHOTO: HAMISH FENTON. NGM MAPS

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FEATURES

112 COMMUNITIES KNOWN AS *QUILOMBOS* HAVE BECOME SYMBOLS OF THE STRUGGLE AGAINST RACISM IN BRAZIL, WHERE INEQUALITY AND STIGMATIZATION PERSIST.

PHOTO: MARÍA DANIEL BALCAZAR

FROM RATS WITH **EMPATHY**
TO MONKEYS THAT **COMPLAIN,**
SOME ANIMALS HAVE
EMOTIONS AS COMPLEX AS OURS.

BY **YUDHIJIT BHATTACHARJEE**

This is Ed. He's a Canadian sphynx cat. He's curious, outgoing, affectionate, and very responsive to human emotion. He's also talkative. Say his name, he purrs. In this portrait, his forward-tilted ears show that he's alert and his narrowed pupils that he's relaxed.

VINCENT LAGRANGE

What are they thinking?

Like family

To observe an octopus, marine biologist David Scheel brought Heidi to live with him and his daughter. As Scheel sipped his morning tea, Heidi stretched, yoga-like, in her aquarium. When the family watched TV, Heidi watched TV. When they returned home, she swished about. “She was happy to see us,” Scheel says. “Or seemed happy.”

QUINTON SMITH, PASSION PLANET

A sense of self

A Japanese macaque stares at its reflection in a moped mirror. Some monkeys appear to recognize the image that they're seeing as themselves, as do apes. Scientists use the so-called mirror test to determine if animals exhibit self-awareness. In humans this attribute develops around 18 months or later.

JASPER DOEST

I

HAVE LIVED for eight years now with my dog, Charlie—a bloodhound who's embarrassingly bad at tracking scents. He greets me jubilantly every time I come home, even if it's from a quick grocery run. I can hear his tail go *thump-thump-thump* on the floor in the next room when I laugh; he echoes my mirth even when he can't see me.

Yet, despite sharing this bond, I often sit down next to him on the couch, give him a hug, and ask my wife, "Do you think he loves me?" "Yes, yes!" she replies, with only slight exasperation, which is charitable because I ask so often.

This routine is almost like a ritual in our household. I wonder if Charlie has any thoughts about it. Looking at him sunning himself on our front porch makes me think about a deeper question: How much do animal minds resemble ours? Do other species have thoughts and feelings and memories the way we do?

As humans, we still think of ourselves as exceptional beings, fundamentally different from other animals. Over the past half century, though, scientists have amassed evidence of intelligence in many nonhuman species. New Caledonian crows snip twigs to fish insect larvae from tree trunks. Octopuses solve puzzles and shield their dens by placing rocks at the entrance. We no longer doubt that many animals possess impressive cognitive abilities. But are they more than just

Body language

Sows, illuminated by light rings, are photographed by animal behavior scientists at Scotland's Rural College. The images are analyzed using an algorithm by experts at the University of the West of England to detect subtle facial expressions. "We are at the stage of reading emotional states in pigs, which is a pretty remarkable achievement," says Emma Baxter, a Rural College researcher.

EVGENIA ARBUGAEVA

sophisticated automatons, occupied solely with survival and procreation?

A growing number of behavioral studies, combined with anecdotal observations in the wild—such as an orca pushing her dead calf around for weeks—are revealing that many species have much more in common with humans than previously thought. Elephants grieve. Dolphins play for the fun of it. Cuttlefish have distinct personalities. Ravens seem to respond to the emotional states of other ravens. Many primates form strong friendships. In some species, such as elephants and orcas, the elders share knowledge gained from experience with the younger ones. Several others, including rats, are capable of acts of empathy and kindness.

This emerging picture of sentience, of rich inner lives, among surprisingly varied nonhuman species represents something of a Copernican revolution in how we view other beings on our planet. Until about three decades ago, the minds of animals were not considered a topic worthy of scientific inquiry. “And animal emotions—well, that was for romantics,” recalls Frans de Waal, an Emory University ethologist who has spent a lifetime studying primate behavior. De Waal was one of the earliest voices advocating for the recognition of animal consciousness. Starting a couple of decades ago, he says, scientists began to concede that certain species were sentient but argued that their experiences were not comparable to ours, and thus not significant.

> **‘The inner processes of many animals are as complex as those of humans. The difference is that we can express them in language; we can talk about our feelings.’**
>
> —FRANS DE WAAL, ETHOLOGIST

Ready recall

A sheep ponders two numbers to pick the one it was taught to recognize. Sheep are good at this. They also remember faces, a high-level social skill. University of Cambridge researcher Jenny Morton says that although sheep are known to flock, they’re easy to work with when alone. “They trust their handler,” she says. “Trust requires emotional intelligence.”

EVGENIA ARBUGAEVA

K9
coil
SIEMENS

Still life

Knopfi, an Australian shepherd being studied at the University of Vienna, learned how to lie motionless in a magnetic resonance imaging machine. Observing dog brains, scientists have found activity in areas similar to those in humans. Words of praise lit up a dog's reward centers. Videos of caregivers activated regions tied to attachment.

JASPER DOEST

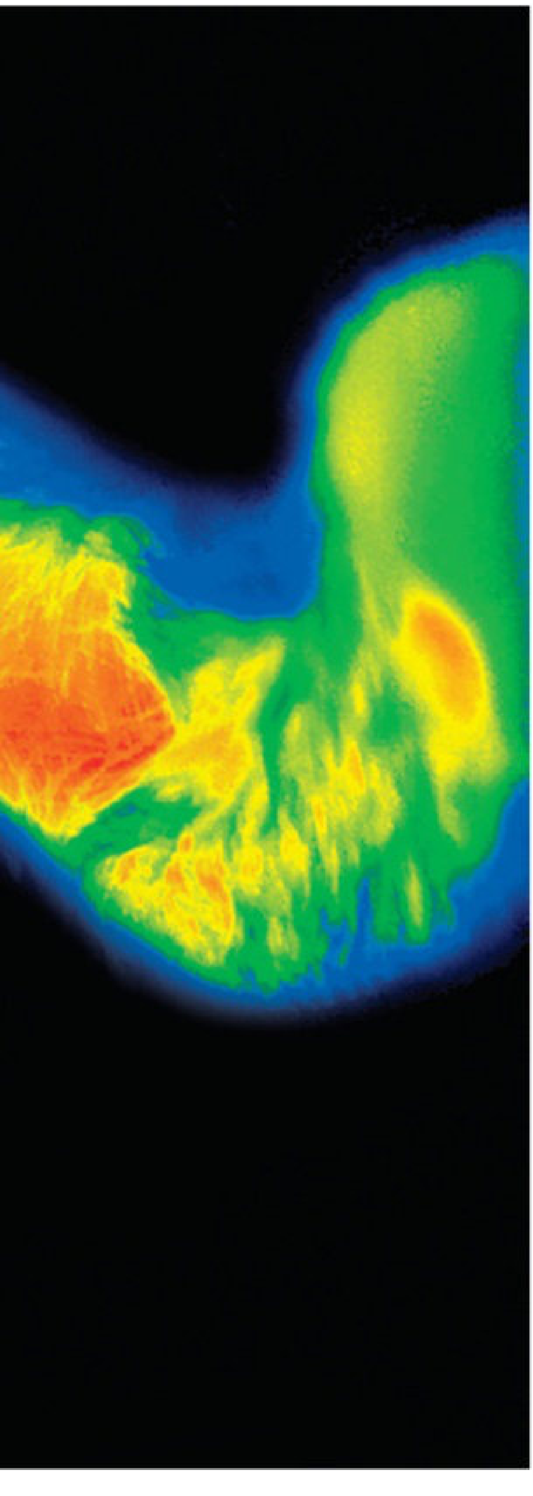
Now some behaviorists are becoming convinced that "the inner processes of many animals are as complex as those of humans," de Waal says. "The difference is that we can express them in language; we can talk about our feelings." This new understanding, if it becomes widely accepted, could spark a complete rethinking of how humans relate to and treat other species. "If you recognize emotions in animals, including the sentience of insects, then they become morally relevant," de Waal says. "They are not the same as rocks. They are sentient beings."

The scientific quest to understand the inner lives of animals, however, is still a relatively nascent enterprise. It's also controversial. In the view of some scientists, knowing the mind of another species is next to impossible. "Attributing subjective feelings to an animal by looking at its behavior is not science—it's just guessing," says David J. Anderson, a neurobiologist at the California Institute of Technology who studies emotion-linked behaviors in mice, fruit flies, and jellyfish. Researchers investigating emotions such as grief and empathy in nonhumans must fend off the charge that they could be anthropomorphizing their subjects.

The way to get closer to the truth is to test inferences made from animal behavior, says David Scheel, a marine biologist at Alaska Pacific University who studies octopuses. "If you look anecdotally through the ages, the notion that dogs are tightly bonded to specific

individuals is very clear. But they are domesticated. Can a fox do the same thing? Does a wolf have that emotional range? Does an orca feel that level of attachment to the members of its own pod? Can a dolphin become friends with a group of fish or a scuba diver? Our intuitions lead us astray here all the time. You will get people whose intuition is, *That's fake. Whatever it is, that's not friendship,* and other people who think, *Well, that's just silly. You are denying animals their inner lives."*

If anthropomorphizing is an assault on scientific thinking, I stand guilty of indulging in it. I take delight in watching videos that show animals displaying behaviors suggesting a range of emotions we identify with. A water buffalo in a zoo enclosure working hard to flip over a turtle that's flailing on its back, then acknowledging cheers from onlookers with what sure looks like a self-satisfied air. A panda sledding down a snow-covered hill, then trudging up to do it again. A monkey on the edge of a canal peeling a banana and gaping with dismay when it plops into the water. I show these videos to my wife all the time, a foolish grin plastered on my face. The idea that life all around us could be pulsating with emotion gives me a happy feeling.



The nose knows

Changa, a chimpanzee at Germany's Leipzig Zoo studied by Max Planck Institute researchers, inspects a thermal imaging camera. When humans are stressed, their noses get cooler. Scientists also found colder noses in chimps that listened to recordings and watched videos of chimps fighting. Seeing a person they knew who appeared to be wounded had the same effect, suggesting the chimps felt empathy.

SEBASTIAN SCHÜTTE AND JOHANNA ECKERT, MPI FOR EVOLUTIONARY ANTHROPOLOGY

These musings are not scientific, obviously, but what scientists do recognize is that emotions didn't evolve in humans alone. Fundamentally, emotions are internal states that drive an animal to act a certain way. We may not think of hunger and thirst as emotions, but they are similar in that they are also internal states that compel action. Scheel describes them as primordial emotions. "When you gotta pee, you will get out of bed on a lazy Saturday morning and go to the bathroom, because you have little choice. It is getting imperative," he explains.

Just like that invisible "imperative," primordial emotions like fear prompt particular actions. Even though emotions like love and sorrow might seem more profound, they are not qualitatively different. "All of our scientific and philosophical work right now," Scheel says, "is pointing to the idea that any emotion you care to name, however lofty and high and ethereal, is built up from these primordial emotions."

If that's the case, it's not hard to appreciate that a wide variety of species—from fleas to chimpanzees—have emotions, primal in some and advanced in others.

THE RAVENS REGARDED ME WARILY, hopping away when I stepped too close to the wire mesh that separated us. Sunlight filtering into the cage shimmered off their silken, jet-black feathers, accentuating their sheen. I'd flown all the way from the United States to Austria to visit them because Thomas Bugnyar, a behavioral and cognitive biologist at the University of Vienna, had made a remarkable discovery about their behavior. After about 10 minutes, the birds seemed to relax. One cautiously shuffled over to get a better look at me, turning its head and sizing me up alternately with its left eye, then its right.

Corvids—the family that includes ravens—are

Shimmering minds

Ravens have remarkable cognitive abilities. Their sharp memories enable them to recall whether a particular person is kind or cruel. They display complex emotional abilities, such as consoling ravens vanquished in a fight, and are keenly attuned to their role in social networks. They also seem to be able to assess what other birds know, a highly advanced level of understanding.

TIM FLACH

known for their intelligence. Scientists have shown that they can use tools, solve problems, and plan for the future. During my visit, I watched one try to hide a treat. First, it placed a small rock over it and walked away. Minutes later, apparently not satisfied, it returned to pick up the treat in its beak, hopped over to a different location, and buried it in the gravel.

Ravens have impressive cognitive abilities, but they also display behaviors that suggest another facet to their intelligence: empathy. While studying raven behavior for his doctorate years ago, Bugnyar noticed that after two birds fought, a bystander that witnessed the squabble seemed to console the loser. He described a typical scene when I visited him in his office, under the gaze of a taxidermied raven—a wedding gift—perched on a branch.

"Two individuals engage in a fight. Now, the victim is chased around for a couple of minutes, eventually escapes into a corner, sits there shaking," he told me. "And the other ravens are very aroused, they are flying around calling, and then one of them flies over to the victim, not directly towards the victim but nearby." Making friendly calls, this raven inches closer until it's within touching distance. If the victim moves away, the consoler persists. "After a couple of minutes, it ends up grooming the other one."

Bugnyar documented 152 such encounters. He and a colleague, Orlaith Fraser, found that the ravens showing support usually knew the victims

well. Researchers had seen consolation behavior in chimpanzees and bonobos; Bugnyar's study was among the first to find it in birds.

Scientists have been able to investigate the phenomenon in greater detail by conducting experiments with rats. In one designed by Inbal Ben-Ami Bartal, a neuroscientist at Tel Aviv University, a rat is confined inside a transparent plastic tube with holes. The tube has a door that can be opened from the outside. The researchers place the tube inside a cage with another rat that is free to move around. The rat inside the tube squirms in a bid to escape. Its distress is visible to the other rat, which begins circling the tube, biting it, trying to dig underneath it. After a few sessions, the free rat figures out how to open the door. Once it has learned this trick, the free rat wastes no time in liberating the trapped rat.

This helpful behavior, though, is contingent on whether the free rat feels a sense of kinship toward the confined one. A free rat raised with others of the same genetic type will help a trapped rat of that type, even if it is a stranger. But if the trapped rat is of a different genetic type, the free rat remains unperturbed by its plight and doesn't let it out. However, if a rat from one genetic type grows up with rats of another, it helps rats only of that other type, including strangers, while ignoring the distress of rats of its own type. "So, it's not about biological similarity," Ben-Ami Bartal tells me. "It's about loving who you're with. It's about having your family and knowing that that's your family."

Mirror image

Magpies—like ravens, a member of the corvid family—are one of a few non-mammals to pass the mirror test. When they spot a mark on their body visible only in a reflection, they try to remove it. This indicates they realize they're seeing themselves. Birds have small brains and no cerebral cortex, but they make up for it with a high density of neurons.

TIM FLACH

A NECESSARY FEATURE of emotional intelligence—including the capacity to respond to a fellow creature's distress—is the ability to read the emotional state of others. On a windy morning, I stood on the edge of a muddy field in the English countryside as psychologist Leanne Proops showed me how she's testing whether horses have this ability.

It's evident Proops, a researcher at the University of Portsmouth, loves her study subjects. Throughout my visit, every time I saw a horse and remarked how sweet the animal seemed, her smile would widen, and her eyes would soften. "Very sweet!" she would reply, invariably.

We leaned two boards against a fence, each printed with a life-size photograph of a horse's head seen from the front. In one, the horse's ears were perked up, the nose and mouth were relaxed, the eyes looked calm—a content horse. In the other, the horse had a threatening look, with ears pulled back, jaws clenched, and nostrils flared.

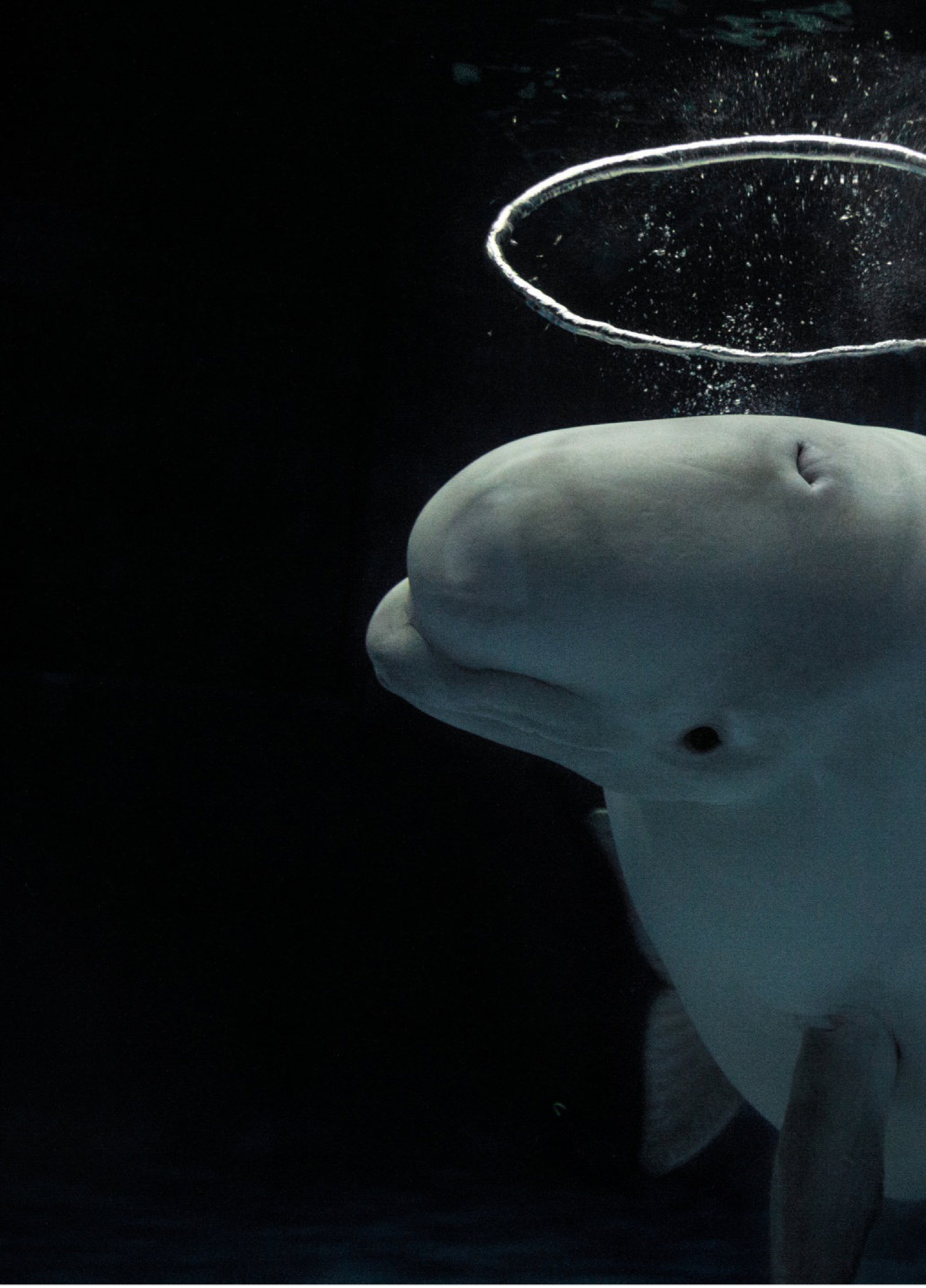
A graduate student led a reddish brown horse out of a barn: our first study subject. She walked it around for a couple of minutes before leading it to the two horse faces, then removed the lead rope. What we wanted to observe was how the horse would respond to the photographs. Would it show greater interest in the happy horse face or the other one?

Proops held her breath. The horse stared briefly at the two images and then sauntered to a corner of the field, swishing its tail and gazing at the grassy meadow beyond. Proops had warned

To the rescue

"Rats," says Inbal Ben-Ami Bartal, a neuroscientist at Tel Aviv University, "show the basic components of empathy." In a study, she tested the rodents to see whether they would free another rat trapped in a tube. She discovered that they help only those belonging to their own social group. Adolescent rats, though, don't discriminate.

PAOLO VERZONE



Ring it up

A beluga in an aquarium in Hamada, Japan, blows a bubble ring. Known to be playful, belugas have been observed making a variety of bubbles with their blowholes and mouths, in essence creating their own ephemeral toys. Often, when one starts to bubble, others join in. Play may have evolved to form social bonds and learn skills, but scientists think animals also like to have fun.

HIROYA MINAKUCHI, MINDEN PICTURES

Horses might have a nuanced ability to read and respond to emotional states not only in horses but in humans too.

me this might happen. Whimsical subjects can confound animal scientists.

The student brought out a splotchy gray-white horse with a soft, shiny mane. This one was more compliant. It stood for a few minutes, contemplating the photos, then went up to the happy face and nuzzled the photo.

Proops and her colleagues put 48 horses through a test like the one I watched. Some had a choice between images of a happy and an angry horse, some were presented with a happy face and a neutral face, and yet others with a neutral face and an angry face. When given a choice between the happy and the neutral ones, the horses had no preference. But they almost always avoided the angry face if it was shown to them, convincing the researchers that horses could recognize the expressions of a horse they had never met.

In another study Proops did, a horse was shown a photograph of a human face that was either smiling or angry. The photograph was shown in the morning. In the afternoon, the person in the photo—or an altogether different person—sat down in front of the horse, with a neutral expression. If the photo the horse had seen happened to have an angry expression, seeing that person in the afternoon caused the horse to display signs of stress. It looked at the person more with the left eye than the right—a behavior horses show when they see a potential threat—tensed up its nose and mouth, and drew its ears back. If the horse saw the photo of a happy face, or if the visitor was a different person, it tended to have a positive or neutral reaction. The findings from this study, also tested on 48 horses, suggest that horses might have a nuanced ability to read and respond to emotional states not only in horses but in humans too. The behavior demonstrates highly advanced skills of recognition and memory. "They've had to transfer from a photograph to a real person. They've had to remember a specific person and, obviously, remember the particular emotion," she said.

"That's amazing," I remarked.

"Yeah, yeah," she said, beaming. "It is."

OCCASIONALLY, CHARLIE MOANS and twitches in his sleep. I can imagine a nightmare that would frighten him—watching a truck bear down on him. He gets jumpy around large, noisy vehicles. But when I stroke his head to soothe him, I'm left wondering what he was dreaming. I'm not alone in wishing I could know what's going on inside the mind of an animal.

When Christina Hunger, a speech-language pathologist who lives in Chicago, brought home a puppy four years ago, she had the same desire. In her work helping children with language delays, Hunger uses a communication device—a board with buttons that produce prerecorded words. She wondered if her blue heeler–Catahoula mix, Stella, could be trained to press buttons for words such as "water," "play," and "outside." Stella was a quick learner and after about a month started using the buttons to verbalize those desires. One day, when Hunger was watering her houseplants, Stella ran to the other room, pressed the button for "water," and came back to continue watching Hunger.

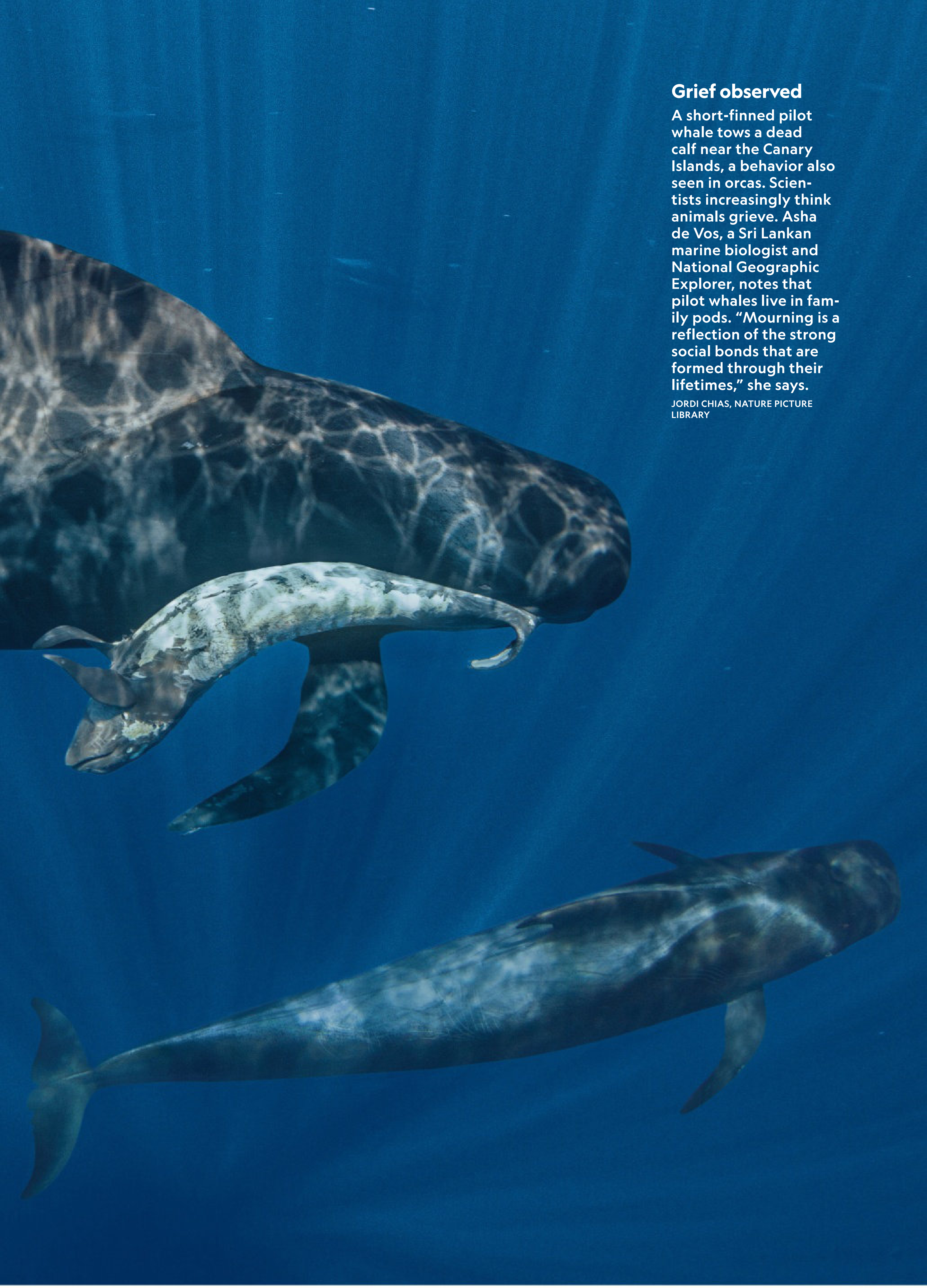
"Her water dish was full. She didn't take a drink of water. She was just using the word in a new way," Hunger says. Stella appeared to be simply pointing out what she had seen.

Excited by the prospect of learning more about

Hand up or handout?

A rescued orangutan named Anih reaches toward Syahrul, an employee of the Borneo Orangutan Survival Foundation who has cared for Anih for years. Anih watched Syahrul struggle to walk in the mucky canal, the photographer says, and finally offered a hand. The photo went viral, but foundation officials caution against anthropomorphizing animal behavior. They think Anih probably was asking for food.

ANIL T. PRABHAKAR



Grief observed

A short-finned pilot whale tows a dead calf near the Canary Islands, a behavior also seen in orcas. Scientists increasingly think animals grieve. Asha de Vos, a Sri Lankan marine biologist and National Geographic Explorer, notes that pilot whales live in family pods. “Mourning is a reflection of the strong social bonds that are formed through their lifetimes,” she says.

JORDI CHIAS, NATURE PICTURE LIBRARY

Love thy neighbor

Viktor, a bonobo at the Fort Worth Zoo in Texas, is known for interacting with visitors. Frans de Waal, an expert on primate behavior, thinks bonobos may have a greater sense of empathy than humans. In bonobos, he says, areas of the brain responsive to the distress of others are larger and pathways to tamp aggression more developed.

VINCENT J. MUSI

In the absence of any other benefit in the moment, it seems likely that play gives animals pleasure, enriching their inner life.

Stella's inner life, Hunger introduced her to a few dozen more words, such as "help," "bye," "no," and "love you." One evening, Stella had something important to say. "She walked over to the 'eat' button and said, 'Eat,' and then walked across our apartment to her 'no' button and said, 'No,'" Hunger recalls. "So she combined those two words to let us know she hadn't eaten dinner."

Hunger then put the buttons in one place—48 in all—to make it easier for Stella to use multiple words, which led to an explosion in communication. "She started combining words together—every day, multiple times a day—to create new messages that I had never taught her that were perfectly consistent with what was happening in the environment at the time," Hunger says. She chronicled her experience in a best-selling book, *How Stella Learned to Talk*.

One day this past spring, Hunger was on the phone when Stella tried to get her attention. She first pressed the buttons for "look," "come," and "play." Hunger was busy, so Stella kept trying different versions of the same message, including "Want. Play. Outside." Finally, frustrated, she pressed "love you," followed by "no." Hunger was flabbergasted. "I never thought that I would introduce a 'love you' button for her to tell me, 'Love you. No,' when she's mad at me," she says. "But it's just amazing to see all the thoughts that are going on in her head."

Stella isn't the only dog to have opened a window to her inner life in this way. In recent years, other dog owners have used communication devices with their pets. The trend prompted Federico Rossano, a cognitive scientist at the University of California, San Diego's Comparative Cognition Lab, to launch a study in which almost 3,000 dog and cat owners have sent reports of their pets using buttons to express words.

Rossano says he's seen numerous examples of dogs inquiring about a family member because the person has been absent. They express their desire to play with specific doggy friends by combining the word "park" with the name of the dog. "It's fascinating how many instances we see where there's two animals in the household and one asks the human for help for the other one," he says. In one video he shared with me, a terrier named Bastian watches his housemate, an old cat named Hallie, sit down because she's having trouble moving. He runs over to the buttons and presses "concerned" and "walk."

I haven't signed Charlie up for this study, but I can imagine he might be eager to tell me what he thinks of my making fun of his lack of sniffing talent all these years: "Funny. No."

DIANA REISS, WHOSE EYES light up when the subject is marine mammals, was filming bottlenose dolphins in an aquarium in the 1980s when she made a startling discovery. She saw one swim to the bottom and exhale a ring of air from its blowhole. As this silvery ring was rising to the surface, the dolphin blew a second, smaller one that rose faster than the first, merging with it to make a bigger ring. The dolphin then swam through it. Reiss, now a cognitive psychologist at Hunter College, couldn't believe what she was seeing. "This was the first time you saw an animal create its own object of play themselves," she says.

It wasn't a one-off. Reiss and others have since observed dolphins in aquariums make rings and toy with them in myriad ways. In the wild, dolphins play chase with one another. They're just one of many species—in addition to dogs and cats, as everyone knows—that engage in play. Baboons have been seen teasing cows by pulling their tails. While studying elephants in Africa, Richard Byrne, who researches the evolution of cognition, often observed young elephants pursue animals that posed no threat, such as wildebeests and egrets. Scientists also have collected evidence of playful behaviors in fish and reptiles, according to Gordon M. Burghardt, an ethologist at the University of Tennessee, Knoxville. He's observed Vietnamese mossy frog tadpoles repeatedly riding air bubbles released from the bottom of a tank all the way to the top.

Play expends energy and even risks injury, yet it does not always serve an immediate purpose. So why do animals engage in it? Researchers believe play evolved because it helps strengthen bonds between members of social groups. It also helps animals practice skills, such as running and leaping, that improve their chances of survival. That's the explanation for why play evolved, but what's the impulse that makes an animal engage in it? A plausible answer—according to Vincent Janik, a biologist at the University of St. Andrews in Scotland—is the pursuit of joy. "Why does an animal do something? Well, because it wants to," he says. In the absence of any other benefit in the moment, it seems likely that play gives animals pleasure, enriching their inner life.

HOW RICH ARE THE INNER LIVES of animals that live in social groups, as we do? Anthropologist Sarah Brosnan of Georgia State University conducts experiments to try to peer into the minds of capuchin monkeys. She took me on a walk around the research facility, which houses six groups of capuchins. Each group has its own outdoor wire-mesh enclosure where the monkeys hang out for most of the day—eating or grooming or playing. It was the middle of the afternoon, and the staff had just finished scattering food.

Of all the food the capuchins get there, grapes are a favorite. Brosnan used that knowledge to devise an experiment to probe their emotional life. She put two capuchins in side-by-side compartments separated by a wire mesh and played a game with them. In the game, which the monkeys learned quickly, they had to hand a "token" to Brosnan—a small object, like a piece of wood—to receive a reward. Sometimes Brosnan gave both capuchins a piece of cucumber, which the animals liked about as much as kids like oatmeal. Other times, she offered one capuchin a cucumber slice and the other a grape. In a third arrangement, there was only one capuchin. Brosnan rewarded this lone monkey with cucumber, but every time she did, she also dropped a grape into the empty compartment.

When both monkeys got cucumber pieces, they ate them without complaint. But when one monkey kept getting a grape, the one stuck with cucumber became visibly upset. It dropped the cucumber or flung it toward Brosnan. The unfairness—or the inequity—was evidently too much for it to handle. In the test with just one monkey that saw grapes accumulating in the adjacent compartment, the animal initially tended to refuse the cucumber but over time went back to eating it. "So they don't seem to mind the contrast as much as they mind the inequity," Brosnan says. The study suggests that an expectation of fairness—and a sense of grievance when it's not met—is probably not unique to humans.

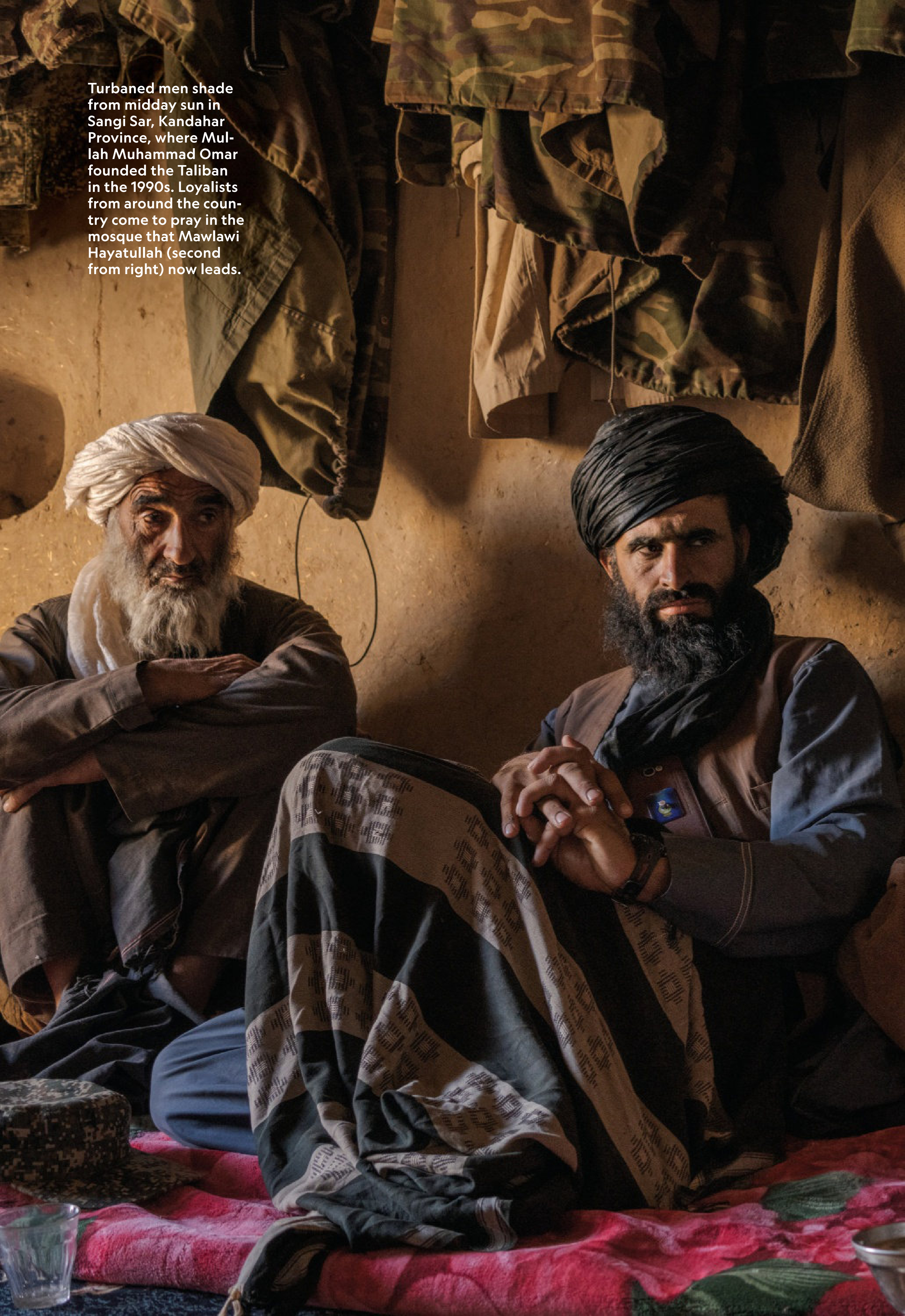
Some primates appear sophisticated enough to have a sense of humor. There is consensus among researchers that chimps—and other great apes—laugh, usually when they're playing. But they also have been seen laughing in other contexts. De Waal tells the story of a colleague who put on a panther mask and emerged out of the bushes across a moat from some chimpanzees. "And the chimps were very angry and threw all sorts of things at him," de Waal says. Finally, the researcher, who was familiar to the chimps, took off the mask and revealed himself. "And some of the chimps—the older chimps—they laughed at this."

I learned of another example from Marina Davila-Ross, a psychologist at the University of Portsmouth, who showed me a video of a young chimpanzee named Pia that she had filmed at an animal park in Germany. Davila-Ross caught the chimp pulling her father's hair in what looked like an attempt to initiate play. When he didn't respond, Pia lay down on the grass.

Shortly after, without any triggering event, Pia's face opened into a wide smile. Then she broke into what can only be described as exuberant laughter, throwing her head back and folding her arms over her eyes, like a child watching a hilarious cartoon.

In Davila-Ross's interpretation, which she includes in a recent research paper, Pia could have been laughing at her recollection of the playful moment with her dad. That surmise can't be proved, of course, but her spontaneous mirth points to an interplay between memory and emotion that would suggest a more complex inner life than we might have imagined. Watching the video brought an immediate smile to my face. I made a mental note to show it to my wife. ☐

Before there was Charlie, **Yudhijit Bhattacharjee,** a contributing writer for *National Geographic,* also enjoyed the companionship of a tortoise, a pair of parrots, and a Doberman named Lasso.



Turbaned men shade from midday sun in Sangi Sar, Kandahar Province, where Mullah Muhammad Omar founded the Taliban in the 1990s. Loyalists from around the country come to pray in the mosque that Mawlawi Hayatullah (second from right) now leads.

AFGHANISTAN'S
LOST ROAD

A 2,000-mile journey on what's left of its major highway reveals a battered nation moving in reverse.

BY **JASON MOTLAGH** PHOTOGRAPHS BY **BALAZS GARDI**

W

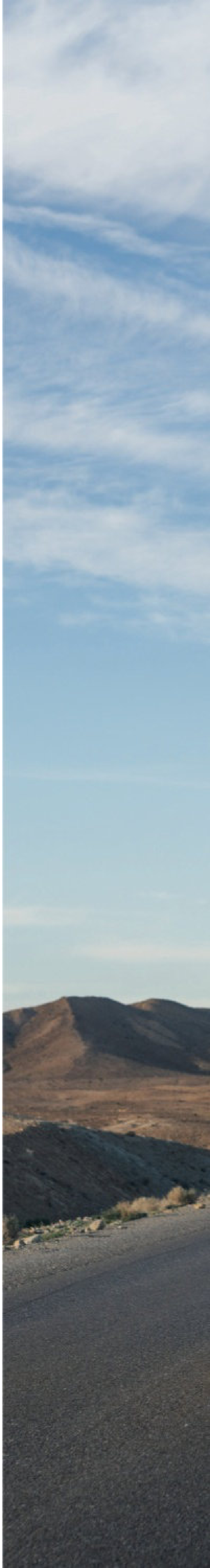
WE'RE FREE AT LAST from the crush of Kabul morning traffic, and the map on my smartphone estimates it'll take nine hours to drive 300 miles to Kandahar on National Highway 1, the most expensive and important road in Afghanistan.

The United States poured hundreds of millions of dollars into this stretch of asphalt—one leg of the 1,400-mile road that circles the country—to speed travel and boost commerce between the nation's capital and its second largest city. But it would be foolish to make dinner plans in Kandahar.

The highway was first built in the 1950s and '60s by the Soviet Union and the United States, Cold War rivals jockeying for influence over Kabul. It was ruined by decades of war and neglect, and only about 30 miles of paved road remained in 2001. When the Kabul-to-Kandahar stretch was repaired and reopened in 2003, U.S. envoy Zalmay Khalilzad proclaimed, "We are standing—literally—on the road to Afghanistan's future ... It is a future of prosperity. It is a future of peace." Nineteen years later, the battered roadway is a bone-rattling testament to the toll of rampant violence and graft that followed instead.

Less than an hour south of Kabul, in Wardak Province, the pavement starts to break apart, pockmarked by craters from Taliban explosives and weakened by ripples in cheap asphalt, forcing me to peel off the road or slam on the brakes repeatedly to avoid accidents. I seldom shift above third gear. Burka-clad widows begging for handouts and boys with shovels are cues to slow down for more bomb damage.

In the absence of repair crews, children such as Ehsanullah, 15, and his brother Rafiullah, 10, pack chasms with dirt from dawn until dark for tips of two dollars on a good day.



A heavily laden truck topped with plastic jugs plies its way through a remote part of Farah Province in western Afghanistan. Drivers say police demanded bribes to allow cargo transport under the old government, when salaries went unpaid and graft was common. The Taliban, they say, aren't doing that now.

PREVIOUS PHOTO

Cattle and goats throng a livestock market in Maimanah, capital of Faryab Province. Years of drought have withered grazing grounds, threatening livelihoods in this mainly agricultural nation.

"Our father is sick, and my older brother is an addict," Ehsanullah sighs. "What else can we do?"

The drive is less stressful than my last trip through this stronghold of the Taliban, the hard-line Sunni Muslim militia that first seized power in 1996 and was ousted by the U.S. in 2001 for sheltering Osama bin Laden after the 9/11 attacks. In August 2020 I was on this road as Taliban militants were hammering Afghan Army convoys. Firefights erupted out of nowhere, and a trickle of civilians traveled at their peril as outgunned government troops hunkered down in bullet-strafed outposts.

The police outpost where I'd spent the night is now a heap of rubble. Dozens more are abandoned, the steel-wire casings from dirt-filled defensive barriers scavenged for scrap. Columns of hard-packed earth are worn down by rains, dotting the hills like a constellation of ancient ruins. Hulks of tanks destroyed during the 1979-89 Soviet occupation sit within eyeshot of mangled American Humvees of more recent vintage, a jarring mash-up of nation-building ventures gone wrong.

It's been a year since the Taliban seized power again as the U.S. withdrew its forces after 20 years. Photographer Balazs Gardi and I have rented a Toyota Land Cruiser to traverse National Highway 1, better known as the Ring Road, which connects four major cities in the east, south, west, and north. In our two decades of reporting in Afghanistan, it was too perilous before to make the full journey. But a lull in violence presents a rare opportunity to explore a country emerging from U.S. occupation.

In dusty urban centers and crumbling villages, we found few traces of the two-decade, U.S.-led modernization project. With each mile, signs of a dark past emerged.

Over two weeks, 18 provinces, and 2,084 miles—including off-road forays on rocky terrain that dent our truck—we meet hardened fighters, itinerant farmers, women enduring draconian restrictions not seen since 2001, and children forced to work to support their families. A unifying thread is relief that a long war that killed more than 150,000 Afghans is over, and a semblance of order restored. But there is also gathering despair that the new Taliban regime is no milder than its original incarnation.

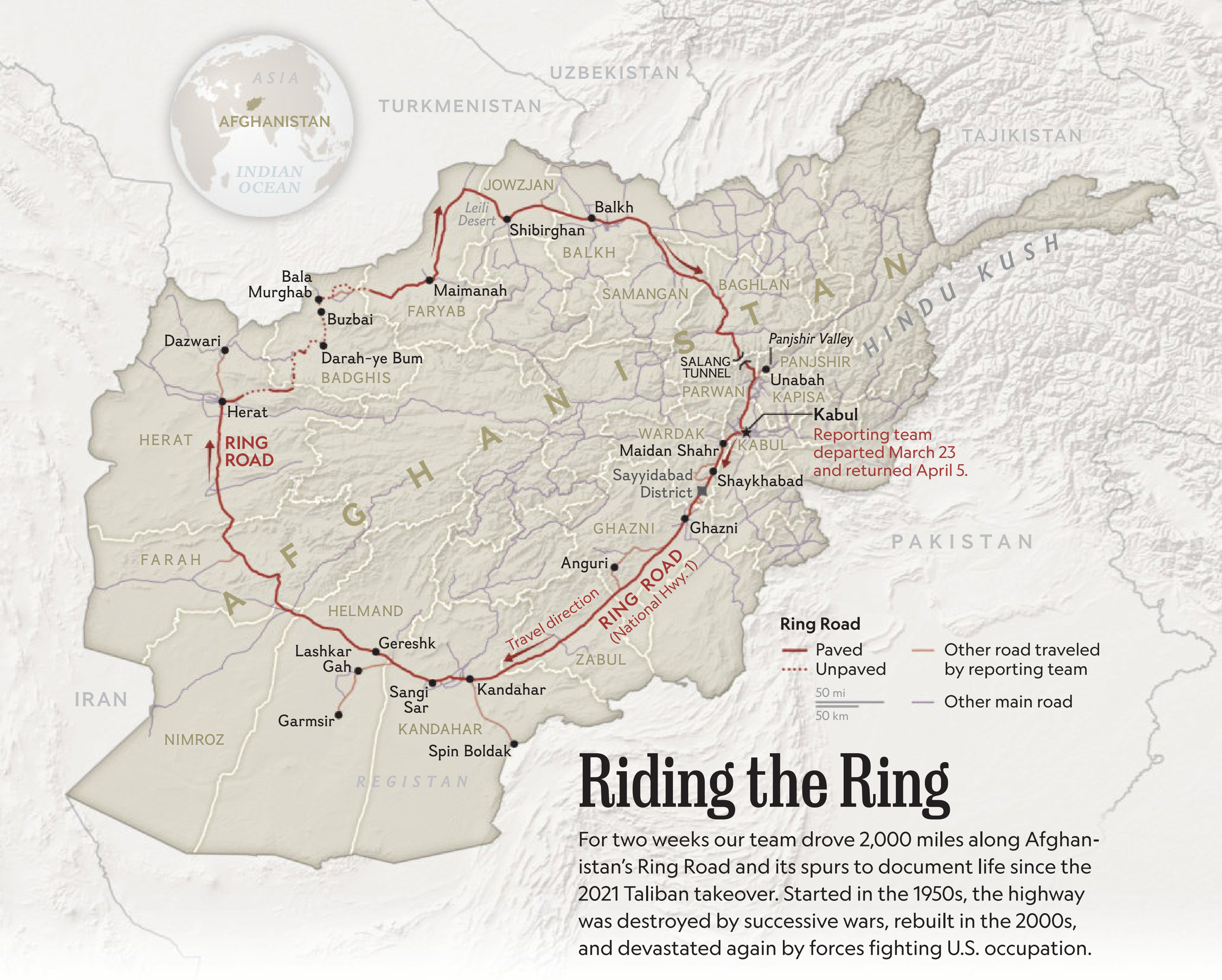
Despite promising amnesty for former enemies and respect for rights of minorities and women, the Taliban have carried out summary executions of government forces who surrendered, have failed to stop sectarian attacks, and have aggressively erased efforts at women's inclusion—from barring them from certain government jobs and forcing women newscasters to cover their faces to banning secondary education for girls. Since the Taliban takeover, the heavily aid-dependent economy has dried up, leaving 95 percent of the population hungry, according to the World Food Programme.

In dusty urban centers and crumbling villages, we find few traces of the two-decade, U.S.-led modernization project. With each mile we drive, ominous signs of Afghanistan's dark and insular past emerge, underscoring a sense of a country moving in reverse.

WE TURN OFF the highway in Shaykhabad onto a gravel road to visit Roshanak Wardak, a physician and outspoken former member of parliament. Wardak, her hair covered by a black scarf, is virtually at a loss for words when we meet. It's the first day of school across the country, and the Taliban have just announced that girls above sixth grade will be barred from attending.

"I am in shock," says a stone-faced Wardak. She plays a cell phone video of a teenager pleading for entry into class. "It means the destruction of her future. A human being without education will be nothing."

Wardak opened a women's clinic in 1996, shortly before the Taliban came to power. Afghan women were dying at alarming rates during childbirth, and Wardak defied conservative authorities by providing medical care while refusing to veil her face. She was among the first cadre of women elected to parliament after the Taliban fell, and in 2010 she returned to being a full-time doctor to treat casualties from the insurgency against foreign forces. She wanted the bloodshed to end and saw the Taliban as the best hope for evicting the U.S. military. She also believed she could have a moderating influence on the Taliban in her community, many of whom she had known since they were boys.


ASIA
AFGHANISTAN
INDIAN OCEAN
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Bala Murghab
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BAGHLAN
Buzbai
FARYAB
Dazwari
Darah-ye Bum
BADGHIS
Panjshir Valley
SALANG TUNNEL
PANJSHIR
Unabah
PARWAN
KAPISA
Herat
Kabul
Reporting team departed March 23 and returned April 5.
HERAT
RING ROAD
WARDAK
Maidan Shahr
KABUL
Sayyidabad District
Shaykhabad
GHAZNI
Ghazni
PAKISTAN
FARAH
Anguri
AFGHANISTAN
HINDU KUSH
HELMAND
RING ROAD (National Hwy. 1)
Travel direction
Lashkar Gah
Gereshk
ZABUL
IRAN
Sangi Sar
Kandahar
Garmsir
NIMROZ
KANDAHAR
Spin Boldak
REGISTAN
Ring Road
Paved
Unpaved
Other road traveled by reporting team
Other main road
50 mi
50 km

Riding the Ring

For two weeks our team drove 2,000 miles along Afghanistan's Ring Road and its spurs to document life since the 2021 Taliban takeover. Started in the 1950s, the highway was destroyed by successive wars, rebuilt in the 2000s, and devastated again by forces fighting U.S. occupation.

The past year has dashed her hopes. The Taliban have reimposed decrees that forbid women from traveling without a male relative, going to parks on the same day as men, or showing their faces in public.

"This is not Islamic," Wardak complains. "All my good opinions of them have changed. The world is going forward; we are going back."

We follow Wardak to the district hospital where she sometimes works, a spartan facility dependent on foreign donors. Afghanistan's backcountry has been hit especially hard by lost aid, U.S. sanctions, and asset freezes, along with low harvests and a harsh winter.

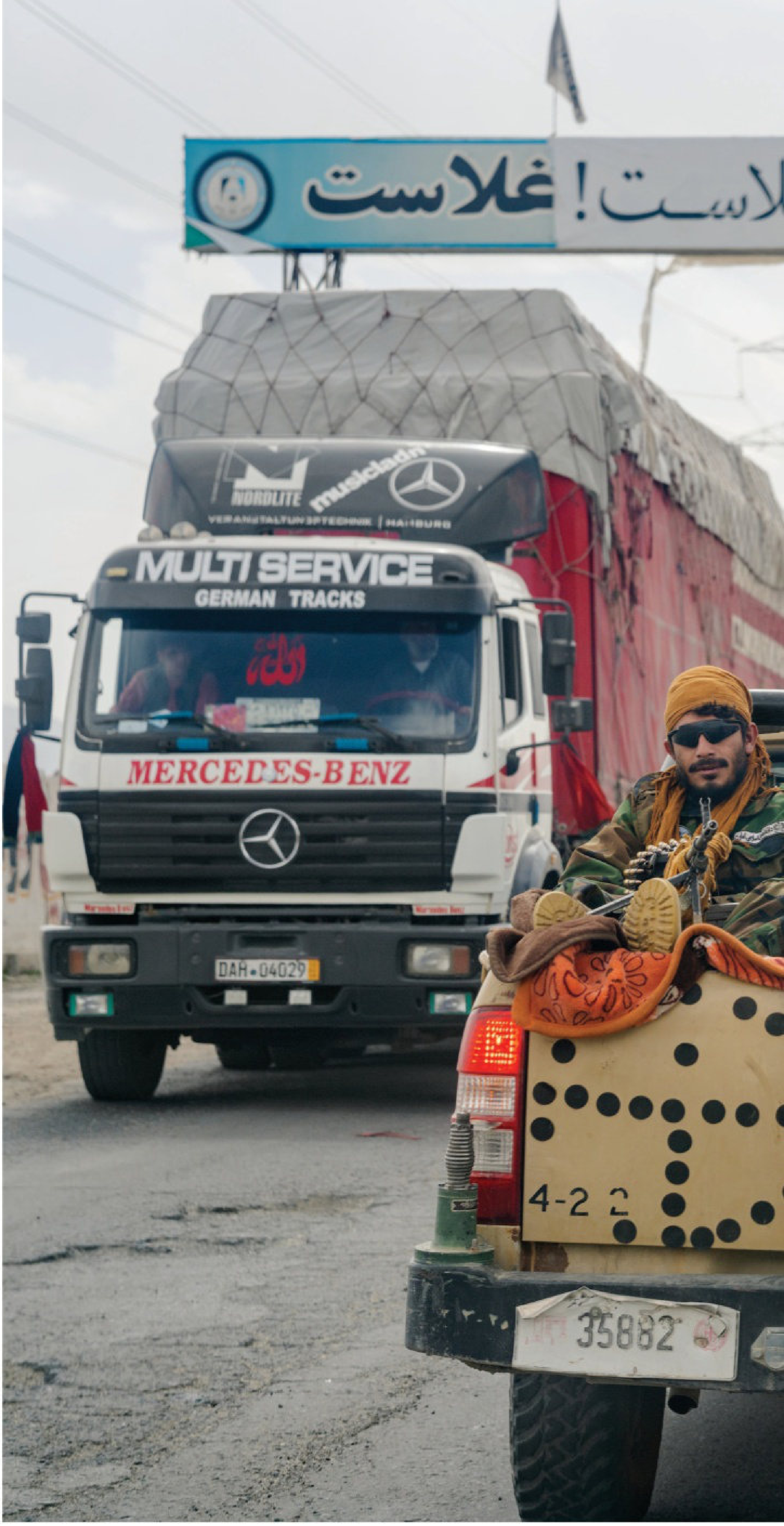
In the malnutrition ward, Ayesha hovers over her withered infant daughter, Reshma, who's being fed through an IV drip. At eight months old, Reshma weighs less than six pounds. Hospital director Abdul Hakim sees 50 to a hundred malnutrition cases a month and expects more. When the Taliban returned, many trained medical workers fled. "Now we don't have enough doctors and supplies to treat people," Hakim says.

Strikingly, the trauma ward is nearly empty. During the war, corpses of government forces and Taliban militants piled up like "stacks of wood" in the lobby, Wardak recalls. Today the lone patient is a trucker getting his cheek stitched after a traffic accident to avoid a bomb crater in the road.

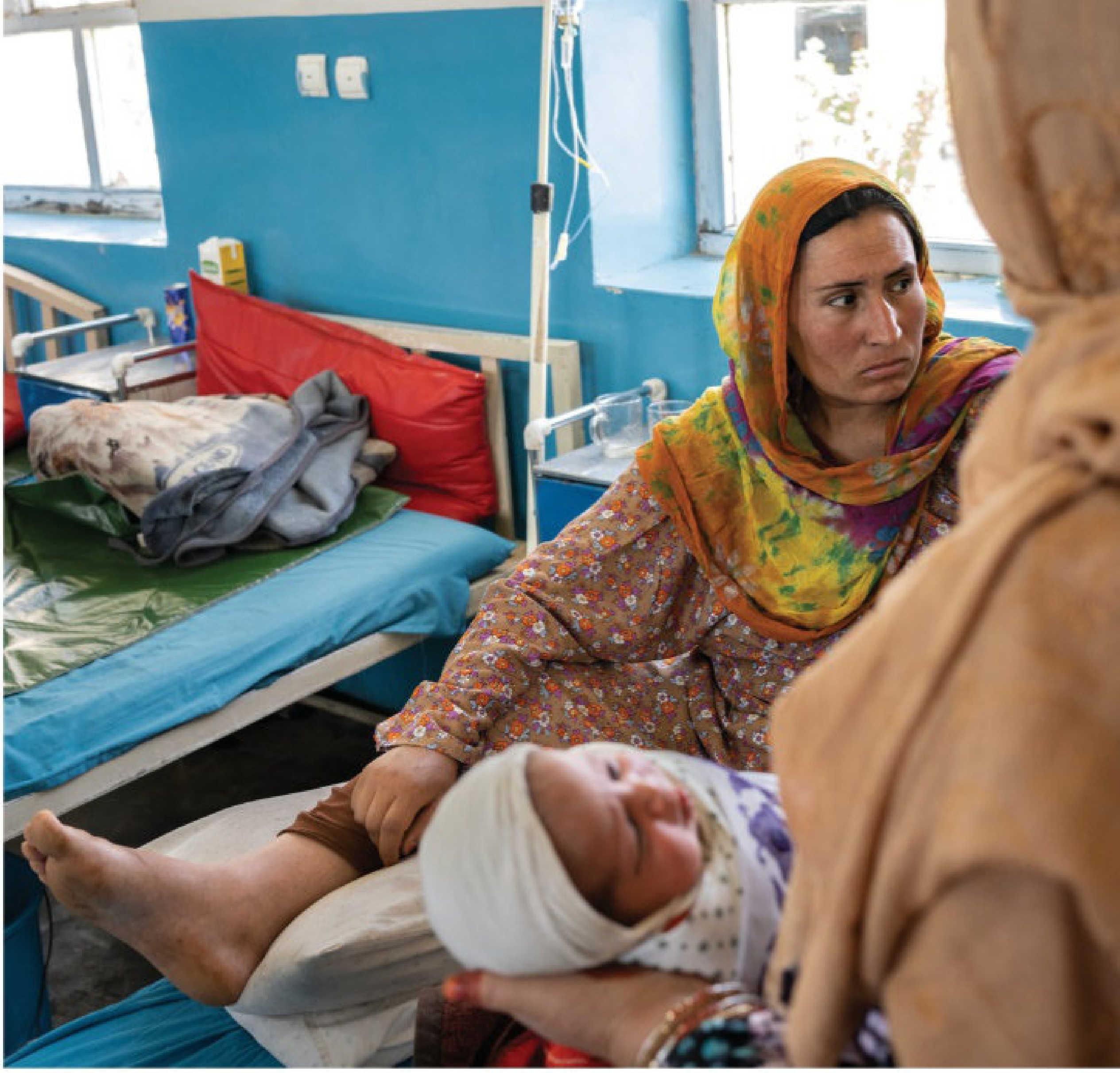
Some miles down the highway, a rangy 50-year-old who goes by the nom de guerre Khan boasts that he's the man responsible for most of the Highway 1 attacks in Sayyidabad District. From 2006 to 2019, he says, his roadside bicycle repair shop was the lookout post for a bomb-emplacement squad that terrorized U.S. and Afghan convoys; by his count, they struck more than 2,500 vehicles. "Sixteen people were killed in that explosion," he says, pointing to a bald patch of pavement. "No one was safe on this road."

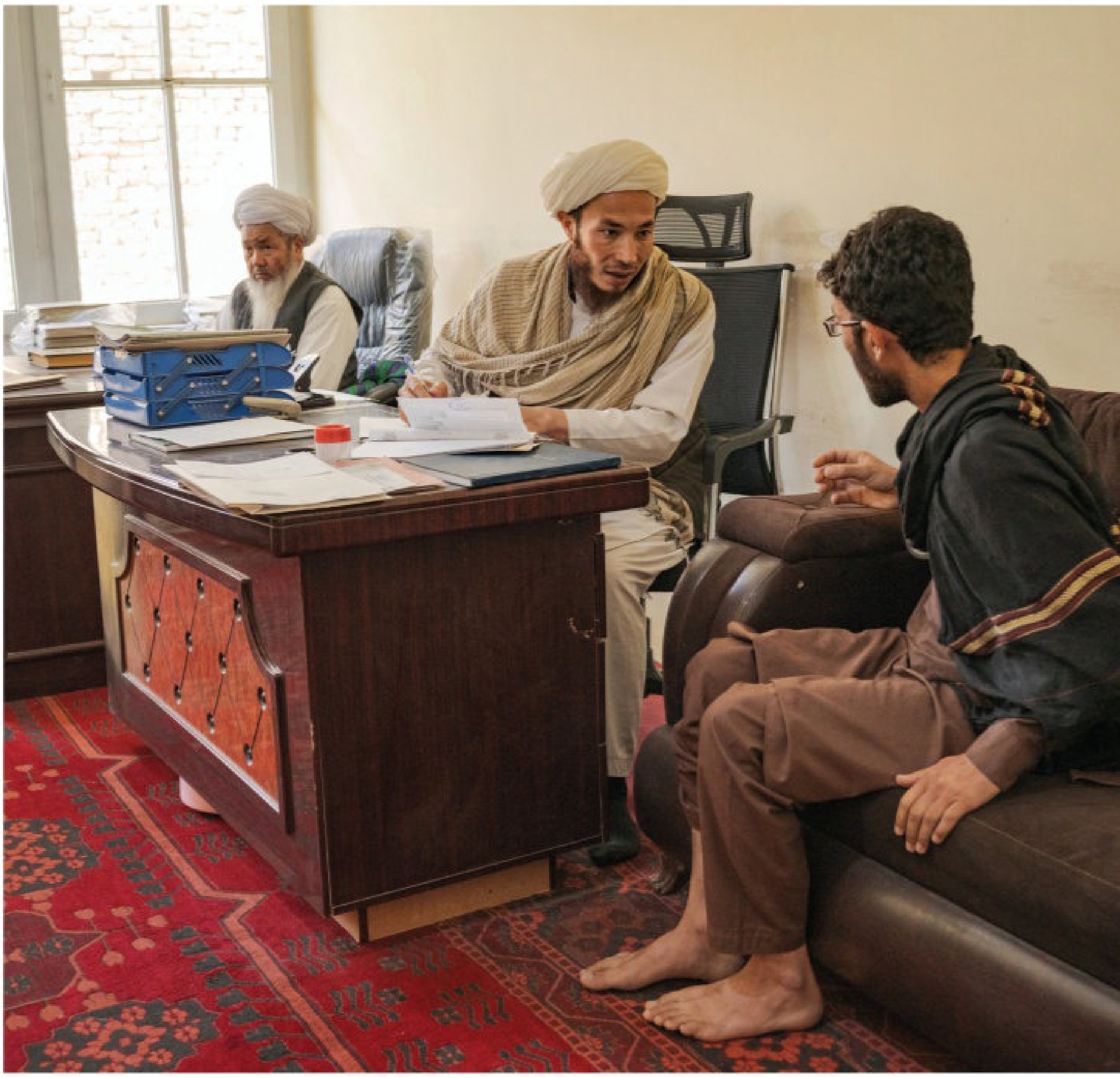
Khan is now a security guard at the Ministry of Public Works in Kabul, an irony not lost on him. Like every Taliban fighter we meet, he says he waged jihad because foreigners were corrupting

CHRISTINE FELLENZ, NGM STAFF. SOURCE: © OPENSTREETMAP



Taliban fighters patrol National Highway 1 near Maidan Shahr, capital of Wardak Province. The gateway to Kabul, this stretch of road was targeted by Taliban bombmakers during their yearslong insurgency against the U.S.-backed Afghan government.





CLOCKWISE FROM TOP LEFT

WARDAK PROVINCE: Wahida, 30, just delivered her fourth child at the Malek Mohammad Khan District Hospital. Afghanistan has one of the world's highest maternal mortality rates; more than 600 women die for every 100,000 live births.

BALKH PROVINCE: Homayoun Morady, 15, from the Hazara ethnic minority, sits in his father's shop while studying math beyond what he's taught at school.

HELMAND PROVINCE: Seasonal workers harvest opium poppies along Highway 1 near the town of Gereshk. Days later in April, the Taliban banned the cultivation, sale, and use of the lucrative crop.

JOWZJAN PROVINCE: A Taliban court in Shibirghan hears testimony from a man accused of selling alcohol. The Quran, the Muslim holy book, prohibits drinking alcohol. Its sale was illegal under the previous government, but the Taliban have stepped up enforcement.

Coal miners shower off after work at a government-owned mine in Baghlan Province. Afghanistan's deepening economic crisis has drawn many men without alternatives or experience into hazardous mining jobs.

Afghans' traditional way of life. With the war over, his animus against outsiders has softened into curiosity, and he invites us for dinner.

Rumbling across a floodplain at dusk, we pass vehicle carcasses staked with tattered prayer flags—memorials to comrades killed by U.S. drone strikes. Woodsmoke rises from the high adobe walls of Khan's fortress compound, and we sit down to a meal of okra stew and unleavened bread, prepared by a wife and daughter we never see.

We're joined by his former comrade who goes by the name Elham, a sturdily built man in a camouflage jacket. The pair reminisce over tea, nostalgic for the charged sense of purpose they once shared. "Before, we suffered but we were happy," says Elham, who now works in a provincial passport office. "Now I'm bored and not sure what to do. I miss the war."

WARDAK PROVINCE'S jagged gray ridges level into washed-out plains as we enter Ghazni Province. The last time I drove here was in an armored U.S. Army convoy, and our trip was cut short when an improvised explosive device killed two Afghan policemen up front. This time, Taliban fighters inspect our trunk for weapons and wave us on with an apology for the hassle.

A sandstorm engulfs the highway, and it's getting dark when we reach Kandahar, the birthplace of the Taliban. In the past year, security has improved and "no one steals a single afghani," Gulalai, a vendor churning ice cream in the main bazaar, tells us, referring to the currency. "We welcome them back." Several stalls down, fabric seller Sabor Sabori counters that while law and order have improved, there's a trade-off: People no longer can speak their minds freely.

"Whether you are happy or sad," he says, "you say you are happy."

Near the city center, the grave site of Abdul Raziq, a fearsome U.S.-backed police commander and Taliban nemesis, has been walled off, his once ubiquitous image stripped from billboards and car windows. At the height of his power he ran Kandahar as his personal fiefdom, lining his pockets with customs revenue while police shook down merchants to supplement meager salaries and henchmen allegedly carried out torture and disappearances. Human rights groups have amassed credible evidence that the Taliban committed revenge killings against former government forces, with some of the most blatant cases in Spin Boldak, the ancestral home of Raziq.

A four-mile line of empty, colorfully painted "jingle" trucks, so called for the chimes that embellish the flatbed vehicles, waits to cross from Spin Boldak back into Pakistan. The crippled Afghan economy relies on imports; nearly 28,000 pounds of commercial cargo pass through this border every day, along with UN aid convoys destined for far-flung provinces.

The Taliban takeover sparked a human exodus for Pakistan and Iran, among them technocrats, doctors, engineers, and other professionals essential to running a functional state. To stem the brain drain and the flight of staff who worked at foreign missions and businesses, the Taliban decreed in February that Afghans without travel documents couldn't leave without special permission.

LESS THAN A MILE beyond Kandahar's city limits, opium poppy fields flare up along the highway. Snow white, pale purple, and lipstick red, the flowers are loudly, enticingly everywhere.

LEFT

Girls crowd into a community school supported by a foreign charity in Wardak Province. Such schools were established in rural and Taliban-held areas before the hard-line Islamic group regained power in 2021, and they were often the only education option. Diminished access to international aid and a ban on secondary education for girls have put the schools' future in jeopardy.

BELOW

Physician Roshanak Wardak, 64, visits maternity ward patients at a hospital in Sayyidabad District, Wardak Province. During the 1990s Afghan civil war, she treated fellow refugees in Pakistan before returning home to address staggering rates of infant and maternal mortality.

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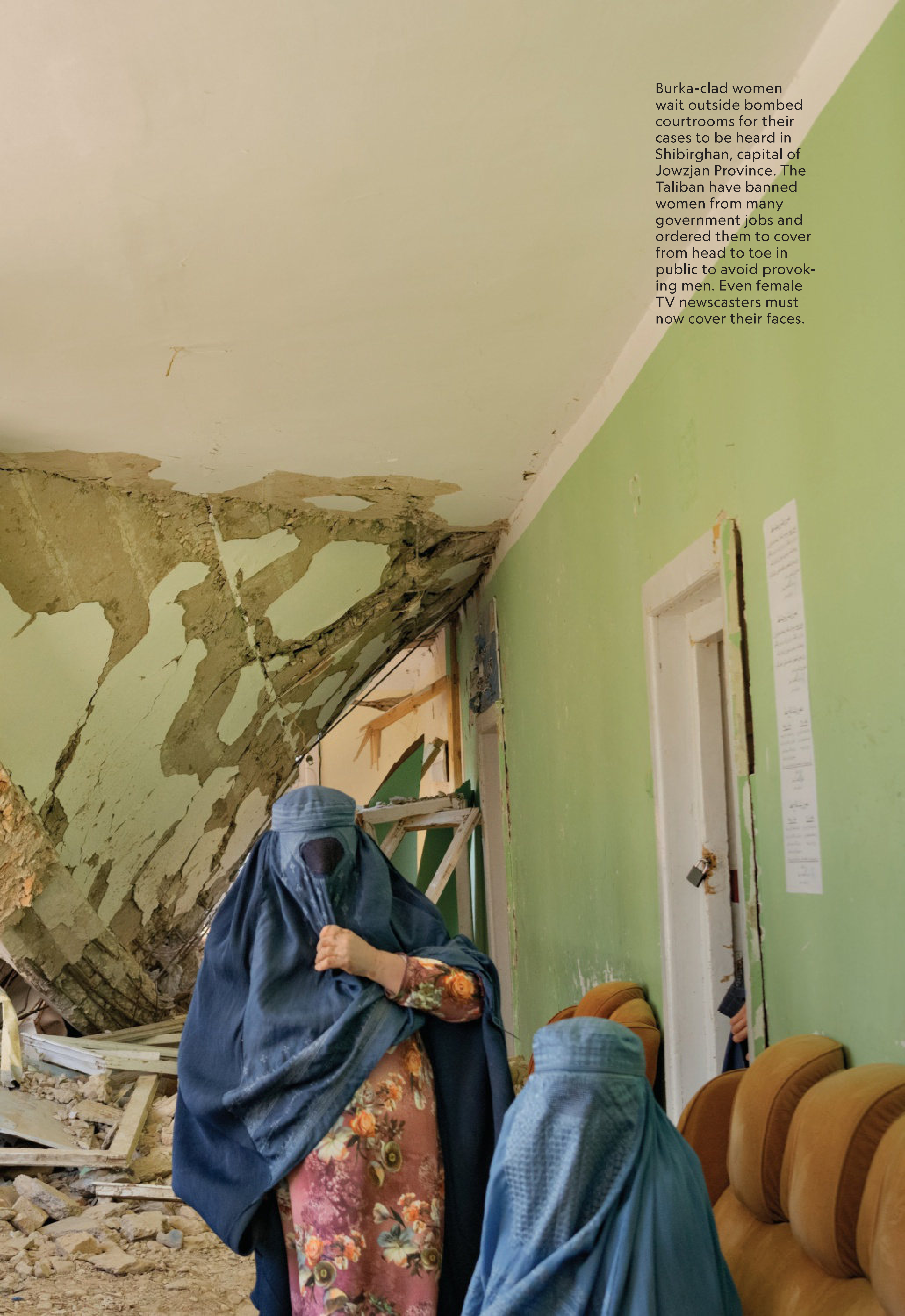


Burka-clad women wait outside bombed courtrooms for their cases to be heard in Shibirghan, capital of Jowzjan Province. The Taliban have banned women from many government jobs and ordered them to cover from head to toe in public to avoid provoking men. Even female TV newscasters must now cover their faces.

Growing opium poppies was banned for the last two years of the first Taliban government; the Taliban later taxed the sale of opium and heroin in regions they controlled during the U.S. occupation. According to the UN Office on Drugs and Crime, Afghanistan was the top producer of opium last year, yielding 7,500 tons worth as much as $2.7 billion, about 10 percent of the country's gross domestic product. Desperate to ease the economic crisis, the Taliban had a choice this year: Crack down and deny rural poor their most lucrative crop—or turn a blind eye.

'Taliban founder Mullah Omar said of the U.S., "You are the most powerful country in the world, and after 20 years you will be the weakest." '

—ABDUL MAJID

I wade into a field and inhale the sickly sweet scent of poppy latex drying in the sun. Ali Jan, 36, scores bulbs with a purpose-made tool, as he has done since he was a teenager. He earns about five dollars a day. "If there were other work, we would leave the opium business," he says.

Under the last government, Jan says, he had to pay kickbacks to local authorities. So far the Taliban aren't interfering, but there's a rumor they will impose a ban after harvest, allowing them to collect taxes now and curry favor later with Western countries seeking to stem the flow of heroin. Despite $8.62 billion in U.S. counternarcotics spending, opium poppy cultivation surged during the war.

Poppy fields multiply down a dirt track to Sangi Sar. The farming hamlet is unremarkable except that it was here that Mullah Mohammad Omar, a one-eyed veteran of the 1980s mujahideen struggle to end the Soviet occupation, formed the Taliban in the 1990s. Warring commanders were killing and thieving during the civil war that broke out after the Soviet pullout, and Omar built a following of fundamentalist religious students known as Talibs, who captured all but a few pockets of the country in 1996.

Omar fled to Pakistan after the U.S. invaded Afghanistan five years later, and died of illness in 2013. His former village home was bombed, but the mosque where he was the imam has been rebuilt. An old comrade, Abdul Majid, tells me that Omar "had the belief that whether he was dead or alive, the [Islamic] emirate would one day prevail. He would say of the Americans, 'You are the most powerful country in the world, and after 20 years you will be the weakest.' "

IN LASHKAR GAH, the capital of Helmand Province, we link up with a Talib named Rozi Billal, whom I'd met months earlier at a sporting event in Kabul. He'd kept in touch, sending family pictures and updates, adamant that we meet again on my next trip. Given his cheerful demeanor and taste for social media, I assumed he was somewhat progressive. I was wrong.

On a rutted road along the Helmand River, Billal, 28, tells us he originally signed up to be a suicide bomber because he was outraged by U.S. air strikes and raids on his community. Taliban officers thought him too smart to sacrifice and tasked him with training bombers instead. For 12 years he led a double life as a militant and part-time university student. Coeducation did little to temper his conservative values. Now a teacher, he insists women be separated.

"Women are a distraction," he says, adding he once had a stubborn female student removed from his classroom for trying to study with men.

The twinkling lights of Herat snap us back to life after a tedious drive through hard, barren country. Afghanistan's third largest city, with more than half a million residents, is an ancient trade center that shares cultural ties with Iran, just 75 miles west. The old city's 15th-century citadel was restored in the 2000s, and the city retains a veneer of prosperity.

But in the districts north of Herat, poverty is stark. There are widespread reports of parents selling daughters into early marriage to afford food for their families, and the sale of kidneys for transplants is on the rise. In Dazwari, a highland village near the Turkmenistan border, residents have relied on USAID and UN food deliveries since drought cut wheat output by more than half and decimated sheep. One in three children is malnourished here, community leader Arbab Nader says. "The [Taliban] government does nothing for us."

In a one-room, mud-brick home, Ma Bibi weaves carpets seven days a week to support her five children, earning $25 for two months' work. Her 10-year-old daughter, Sharifa, now toils alongside her. "I wanted to be a teacher, but that is no longer possible," the girl says with resignation.

IN BADGHIS PROVINCE, one of the country's poorest, makeshift camps of displaced people straddle the highway, waiting for aid deliveries that no longer come. The pavement crumbles into patches of dirt, until it disappears.

At a remote checkpoint in Darah-ye Bum, a Taliban guard looks bemused when I tell him we're driving to Maimanah in Faryab Province, the next major city 145 miles northeast. We start up a steep mountain track, and a boy runs up to warn us it's too dangerous, redirecting us into a riverbed. I check my smartphone map, which confirms we are still on National Highway 1: The riverbed *is* the road.

So begins a punishing ride down a boulder-strewn canyon. Several times I get out and move rocks to continue. We grind on for the rest of the day, averaging two miles an hour, not another vehicle in sight. It's dark when we reach Bala Murghab, a dead-end town of fire-scorched ruins.

We stop at a filthy teahouse and eat tough kebabs in silence. A shopkeeper lets us crash on his floor, but we hardly rest. The route to Maimanah is off-road, and we must follow a predawn taxi to avoid getting lost. Soon we're slashing through hill clefts and edging along steep ravines, one rockslide away from tumbling into the abyss. There's no choice but to keep chasing the taxi's taillights and white-knuckle our way through a gantlet of climbs and drops.

When the pavement finally reappears five hours later, we emerge as if from a fever dream. "The Ring Road is a myth," I say aloud, wondering how many people could have driven the entire circuit. For all the claims of mapmakers and military planners, Afghanistan's celebrated highway is another overhyped nation-building project left incomplete.

THE SMOOTH, SLEEPY DRIVE into Shibirghan, the capital of Jowzjan Province, is a welcome relief. But the sun-blasted desert that surrounds the highway is haunted by a brutal past.

We pass the turn to Dasht-e Leili, where in late 2001 as many as 2,000 Taliban fighters captured by Uzbek warlord Abdul Rashid Dostum suffocated in shipping containers and were dumped in mass graves. Dostum became first vice president and then marshal of Afghan armed forces while reigning over Jowzjan with absolute power for the past two decades, living lavishly in palatial homes in Afghanistan and abroad.

An energetic Taliban information officer named Hilal Balkhi informs us that we drove past a recently discovered mass grave. Scattered bones had been spotted along the highway, and a man came forward claiming to have seen Dostum's fighters bulldozing bodies in 2001. Desert winds had licked the concealing sands away.

Balkhi cancels an appointment to show us the site. He drops to his knees and starts digging with his hands, unearthing jawbones, femurs, shreds of clothing. He moves to the next pile and the next, and vows there will be justice under the new regime.

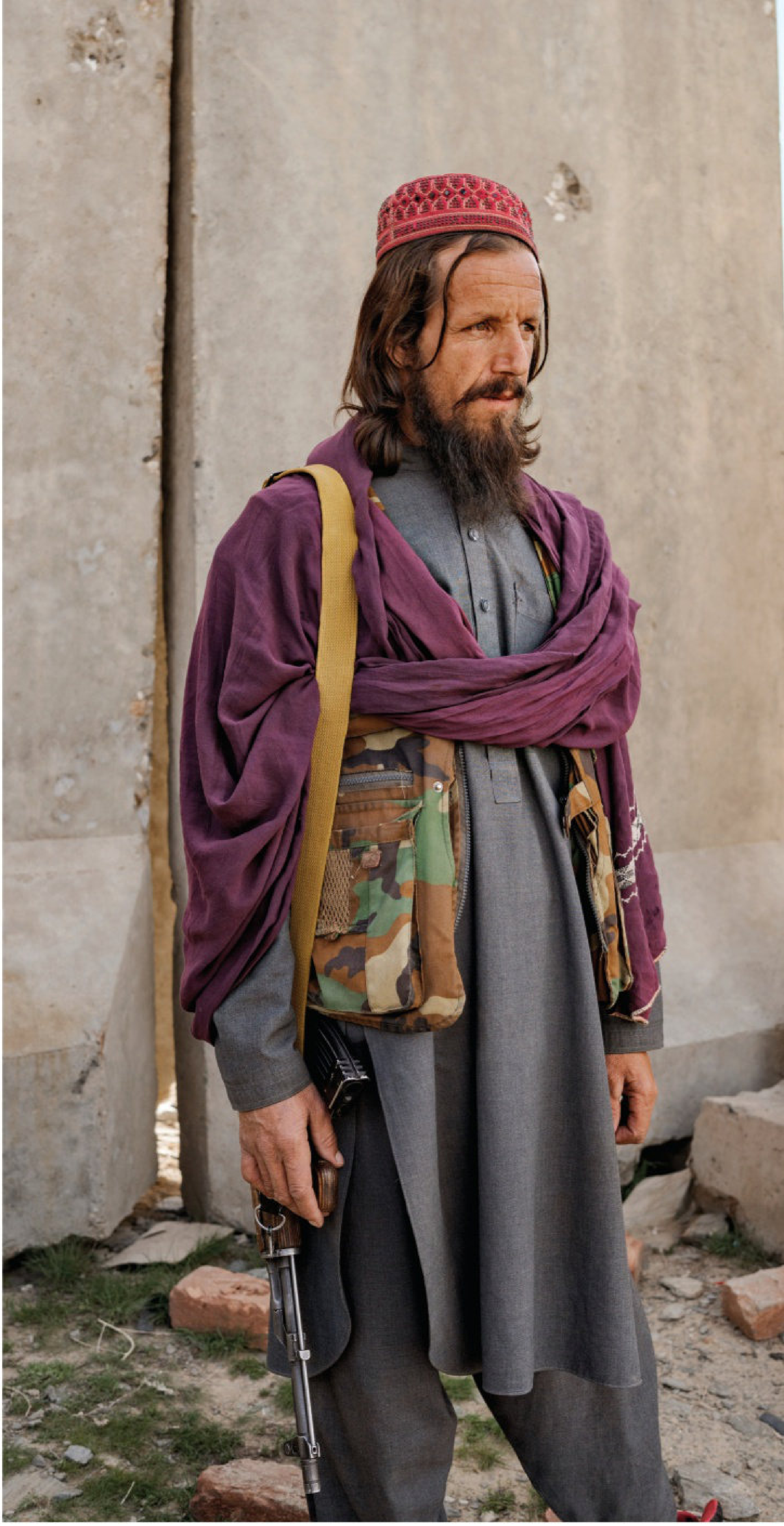
At the bombed-out provincial court building, people are arguing their cases before turbaned clerics. Many disputes involve land. Ahmad Javed, 39, a clean-shaven IT professional in a leather jacket, alleges that Dostum cronies seized his land. Dostum's people "could do anything" under the last government, he says. "They beat me up and broke my left hand. I feel very happy the emirate is here; they uphold Allah's law, not the will of strongmen."

UNDER THE FIRST Taliban government, justice was summary and brutal: public hangings for murder and rape, amputations for theft. Mufti Zahed, Jowzjan's chief justice, affirms that the death penalty and dismemberments would again be enforced, though he'd not done so yet.

The Ring Road turned out to be a myth. The celebrated highway is another overhyped nation-building project left incomplete.

I notice a leather paddle on his desk and ask if he's ever used it. "Only once," he smirks, recalling a man who ignored warnings to stop cursing in his office.

That day the Taliban announce a ban on opium, from its cultivation to its use and sale. With government assets frozen and scant diplomatic recognition, the Taliban seem to be trying



RIGHT

Taliban fighter Omara Khan Mazlomyar, 40, stands guard at a former police outpost near Maidan Shahr, Wardak Province. An avid poet, he recites lengthy verses lamenting the vices of the past government and extolling the virtues of the Taliban.

FAR RIGHT

Abeda and her brother Ehsanullah ride their donkey home past the shrine of Amir Agha near Garmsir, Helmand Province. UNICEF calls Afghanistan the world's hardest place to be a child because of high child mortality rates, malnutrition, widespread hunger, and rampant sexual abuse.

An unpaved section of Highway 1 cuts through the village of Buzbai in Badghis Province, one of the country's poorest. The Asian Development Bank was supposed to pave the road from Badghis to Faryab years ago, but security risks and supply shortfalls halted the work.

Once the center of a powerful Islamic empire, the old city of Ghazni, capital of Ghazni Province, has fallen into disrepair from war and mismanagement. Most residents have decamped to the new city, where services are better.

to gain favor with the international community.

Mawlawi Gul Mohammad Saleem, deputy governor of Jowzjan, concedes “there were problems” during the last Taliban regime. A delegate at Taliban peace talks with the U.S. that were held in Doha, Qatar, he says the movement’s leaders have traveled widely since the 1990s and want to engage with the world, not seal off the country as before. U.S. geologists estimate Afghanistan has a trillion dollars’ worth of untapped minerals—enough to lift millions out of poverty if foreigners invested in infrastructure.

THE FINAL STAGE of our journey is the 1.6-mile-long Salang Tunnel at an altitude of 11,000 feet, carving through the Hindu Kush, the mountains that divide the north from Kabul. A daring feat of Soviet engineering designed to handle a thousand vehicles a day when it opened in 1964, the passage has degenerated into a muddy, potholed, smog-choked shaft through which as many as 9,000 vehicles drive each day. An untimely breakdown could snarl domestic trade, spike gas prices, and mean death for those trapped inside.

The mouth of the tunnel is belching smoke as we enter. Visibility drops to zero. What seems like an eternity later, we emerge from the black lung and pull over to suck down fresh air before a winding descent to Kabul.

There’s one more detour to make: to the Panjshir Valley, the fabled bastion of resistance that
the Soviet Army and first Taliban go
never managed to tame. Panjshir aga
when every other province fell in rap
sion in summer 2021, but Taliban figh
punctured its myth of impenetrabili

The road into the valley knifes along
walls and a rushing emerald river. Bill
once featured the late commander Al
Massoud and other ethnic Tajik heroe
faces scratched out. The mood is som
holdout of anti-Taliban sentiment.

“Maybe five out of every hundred f
left—only people who couldn’t affor
says Habibullah, a bakery owner in U
lage. Every other shop is shuttered. “
he says, “is everywhere.”

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What's left of Panjshiri resistance has retreated up the mountains. Grainy videos on social media and funerals for slain Taliban indicate there's still fighting. But for now, resistance is mostly symbolic.

When we reach Kabul, a massive new Taliban flag billows over Wazir Akbar Khan hill, a park in the city center. A gathering there has the boisterous feel of a family reunion—minus any women. Fighters from across the country laugh and take pictures, savoring their moment at the top after years in obscurity.

But the Taliban's transition from guerrilla movement to government is taxing Afghans' patience. New decrees are curtailing personal and media freedoms, and the nation is largely cut off from trade and aid, plunging the economy into free fall. Food, jobs, and health care are scarce. Infrastructure is a shambles.

"We have spent our entire lives in conflict, so I can predict the future," says Abdul Khaliq, a 50-year-old laborer who lived through the Soviet invasion, the civil war, and the U.S.-led campaign. "This country will not be rebuilt for another 50 years."

On our last day we drive back to Shaykhabad to see Wardak, the doctor. Her fatalism on the day the Taliban banned older girls from school has been replaced by defiance. She is delivering notebooks and pens to a community-based girls school she supports.

In a private compound, high in a mud-walled hamlet miles from a paved road, girls as young as six are cramped together on the floor of a small room, reciting facts about the circulatory system. Wardak complains the quality of education is not good—no tests, few textbooks—but at least the girls are learning something, fueling "hope that maybe one day they will return to school."

Back at home, Wardak has something to show us. Past a grove of apricot trees and rosebushes is a hidden stone building with a vacant terrace.

"If the Taliban does not allow girls to go back to school, I will build one here," she declares, the vision sparkling in her blue eyes. "I've made up my mind to stay and resist however I can—it is my duty as an educated woman. The next time you come here, this place will be full of beautiful voices." □

For the September 2021 issue, **Jason Motlagh** reported on Afghan youth and the urban-rural divide on the eve of the U.S. pullout. Photographer **Balazs Gardi** first visited Afghanistan in 2001.

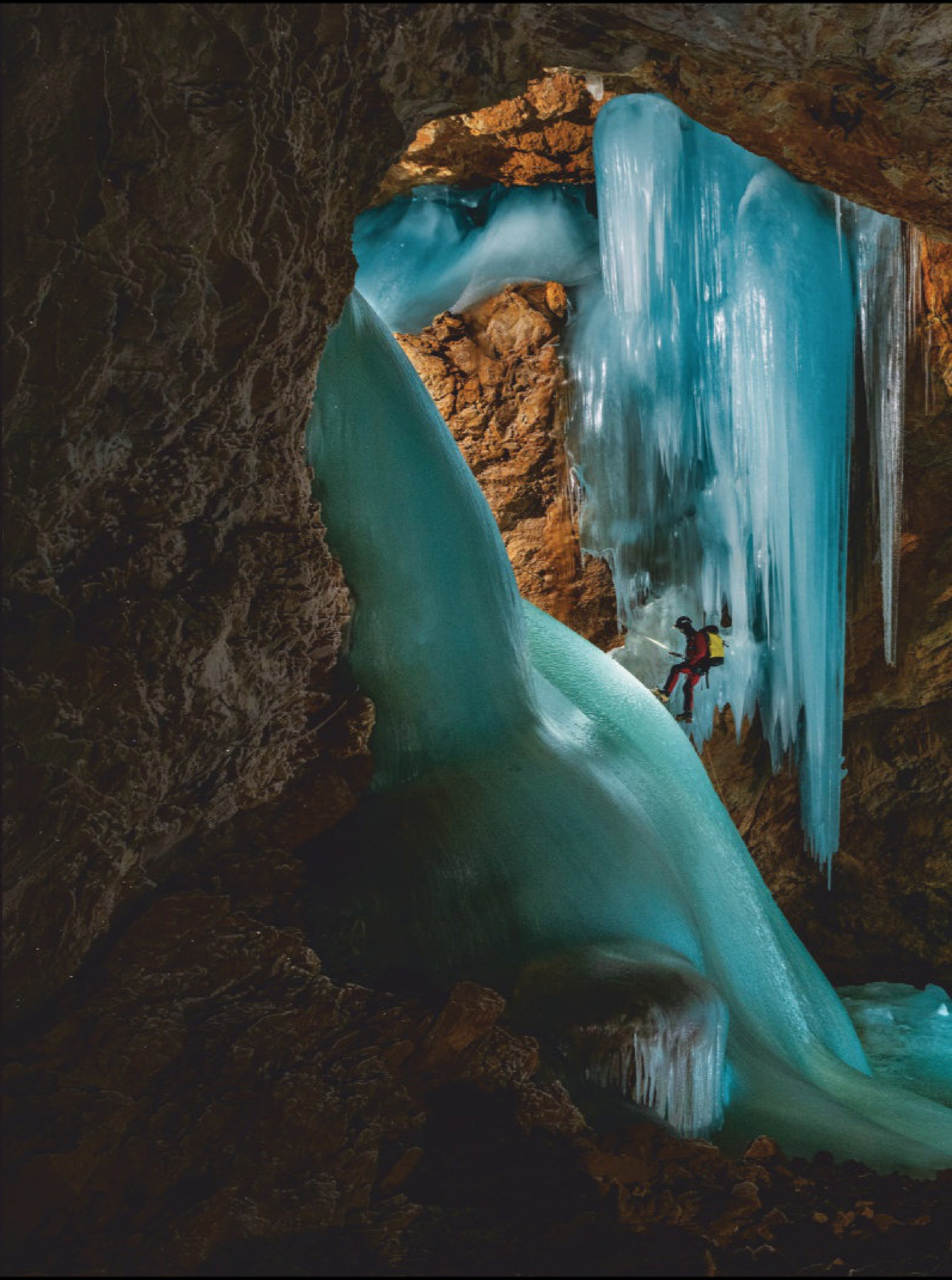
ICE CAVES IN THE ALPS ARE AMONG THE PLANET'S GREAT WONDERS. NOW WARMING THREATENS THIS SPECTACULAR UNDERWORLD.

Delicate crystals of hoarfrost take shape where moisture and cold air meet in a sheltered spot of Eisriesenwelt, an Austrian cave famous for its giant ice formations.

WHEN THE MAGIC

BY **DENISE HRUBY**

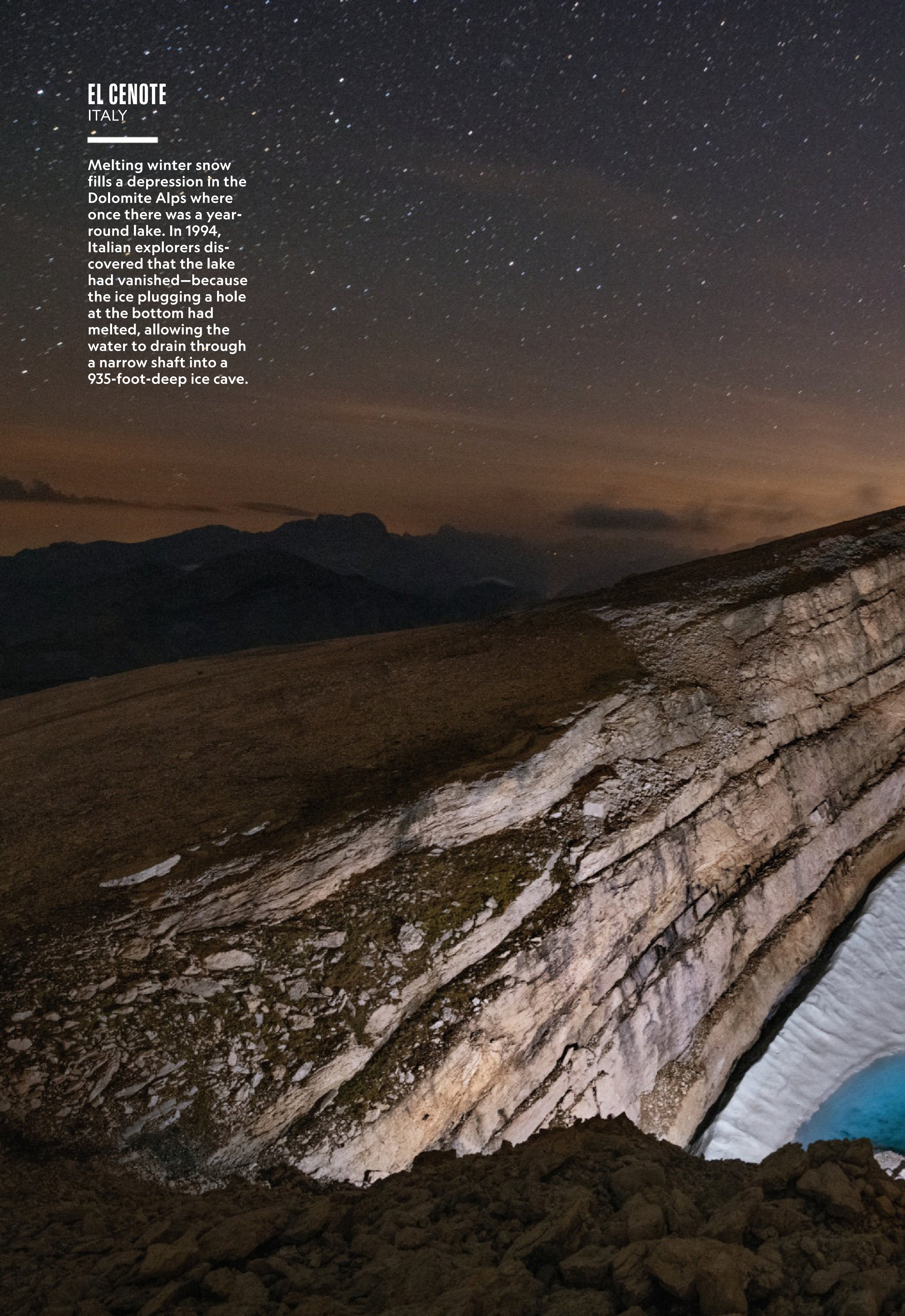
PHOTOGRAPHS BY **ROBBIE SHONE**



EISKOGELHÖHLE
AUSTRIA

Water percolating into freezing alpine caves like this one, high in the Tennen Mountains south of Salzburg, sculpts itself into mesmerizing structures: huge Damoclean icicles, cones rising from below, and floor-covering cascades. They can be thousands of years old.

MELTS



EL CENOTE
ITALY

Melting winter snow fills a depression in the Dolomite Alps where once there was a year-round lake. In 1994, Italian explorers discovered that the lake had vanished—because the ice plugging a hole at the bottom had melted, allowing the water to drain through a narrow shaft into a 935-foot-deep ice cave.

The National Geographic Society, committed to illuminating and protecting the wonder of our world, has funded Explorer Robbie Shone's cave photography since 2018.

ILLUSTRATION BY JOE MCKENDRY

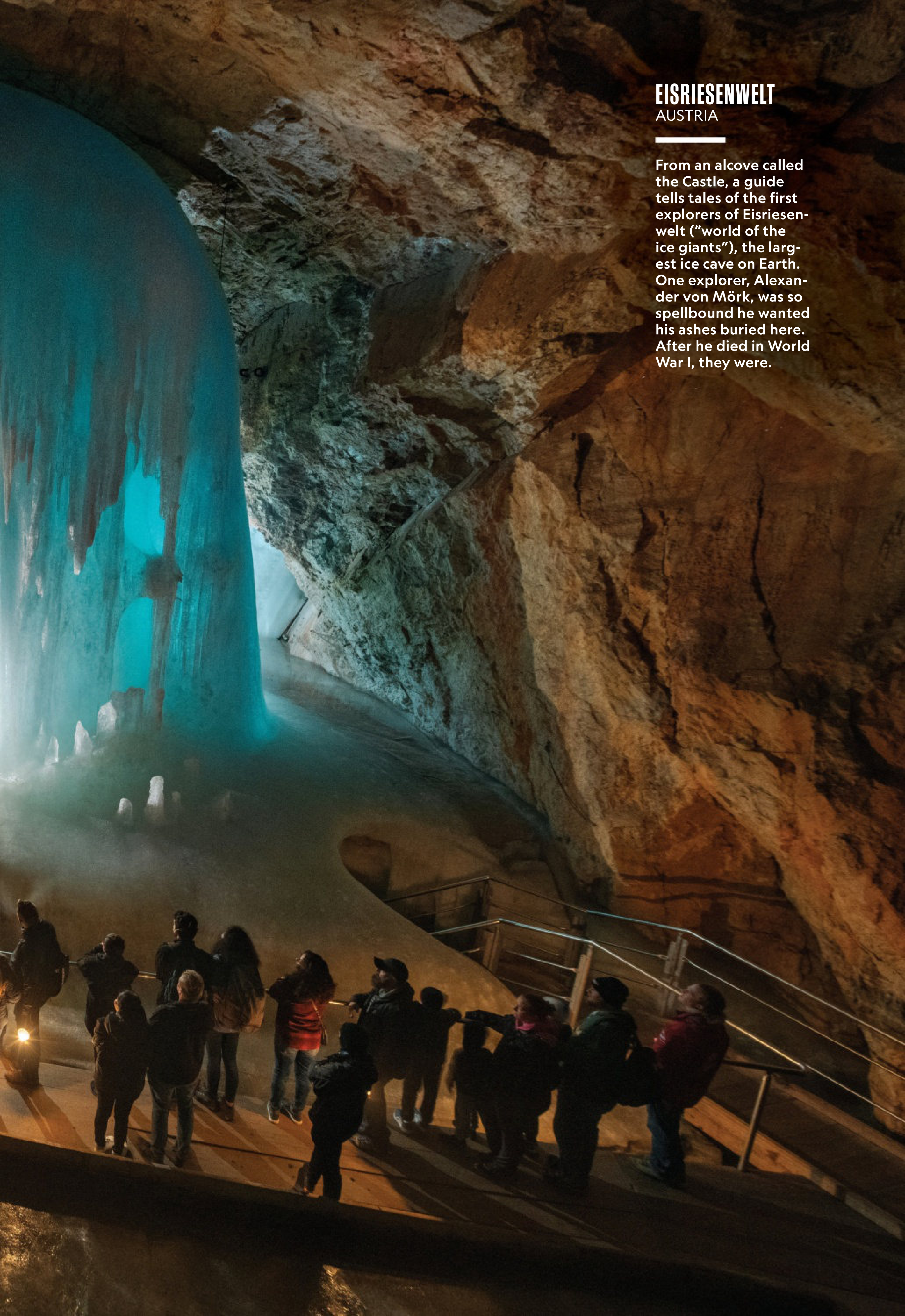
HOCHSCHNEID
AUSTRIA

In a cave east of Salzburg, paleoclimatologist Tanguy Racine of the University of Innsbruck picks twigs and pine needles from ice for carbon dating. That can reveal when the ice formed and how it has waxed and waned over millennia as the climate has changed.

A

AS A CHILD, KAROLINE ZANKER had a magical playground. From her home in the quaint Austrian village of Sankt Martin bei Lofer, near Salzburg, she'd hike past a little pilgrimage church and up into the Lofer Mountains, just below the tree line where even hardy larches cease to grow. At an altitude of about 5,200 feet, under the lofty peaks, she'd slip through a narrow portal in the limestone and crawl right inside the mountain. Prax ice cave, she says, was just like a fairy tale.

Ice poured down from the cave ceiling like frozen waterfalls, and towers of it rose from the



EISRIESENWELT

AUSTRIA

From an alcove called the Castle, a guide tells tales of the first explorers of Eisriesenwelt ("world of the ice giants"), the largest ice cave on Earth. One explorer, Alexander von Mörk, was so spellbound he wanted his ashes buried here. After he died in World War I, they were.

floors of corridors hundreds of yards long. Ice crystals and icicles glittered like precious gems on the walls.

"It was incredibly marvelous," recalls Zanker, now 48 and working as a cave guide.

That fairy tale is forever lost because of climate change. Last fall, I crawled, climbed, and wriggled through Prax ice cave for hours, directing my headlamp into the farthest nooks, hoping to spot at least a remnant of what had captivated little Karoline all those years ago. But the thermometer showed about 3 degrees Celsius (37.4° Fahrenheit). Even in the most expansive gallery, there wasn't a crystal of ice to be found.

"It might be time to take the 'ice' out of the cave's official name," Zanker says.

CAVES FORM MOST OFTEN in limestone and dolomite—rocks that are particularly dissolvable. Over hundreds of thousands of years, water seeping down from the surface washes out shafts and branching corridors and cavernous rooms that may be large enough to hide rivers and lakes. Minerals sometimes precipitate out of the water that drips into the caves, forming stalactites that hang from the ceiling and stalagmites rising from the floor.

Stretches of the Alps are rich in such caves—and some are cold enough for ice to grow inside instead of stone. No one knows exactly how many ice caves there are, but they undoubtedly are more numerous here than anywhere else: About 1,200 have been found in Austria alone, and several hundred more in northeastern Italy.

Some are just open pits that trap colder, heavier air at the bottom. In others, a difference in elevation between entrance and exit points creates a powerful chimney effect: In winter, when outside temperatures drop well below those inside, the warmer, more buoyant air in the cave begins to rise and escape through higher-up exits, sucking cold, fresh air into the lower-lying entrance points. That chills the cave. In summer, the airstream is reversed: Warm air, sucked in at the top, is chilled by the rock as it descends, and cold air blows out through the lower entrance. The chimney effect usually keeps the lower sections of the cave, where perennial ice can be found, at a relatively constant low temperature year-round.

AT THE BOTTOM OF THE SHAFT, WE LAND ON SOFT SOIL. DARKNESS ENVELOPS US. A FEW YARDS IN, OUR BOOTS CRUNCH: **WE'VE HIT ICE.**

When that temperature is cold enough, water dripping into the cave freezes into mesmerizing, ever changing shapes. Icicles many feet long or wide festoon the ceiling. Thick ice sheets cascade down the walls. On the floor, the slow drip can gradually build ice cones several floors high or enormous rinks that seal off entire shafts. In some caves the oldest ice dates back thousands of years.

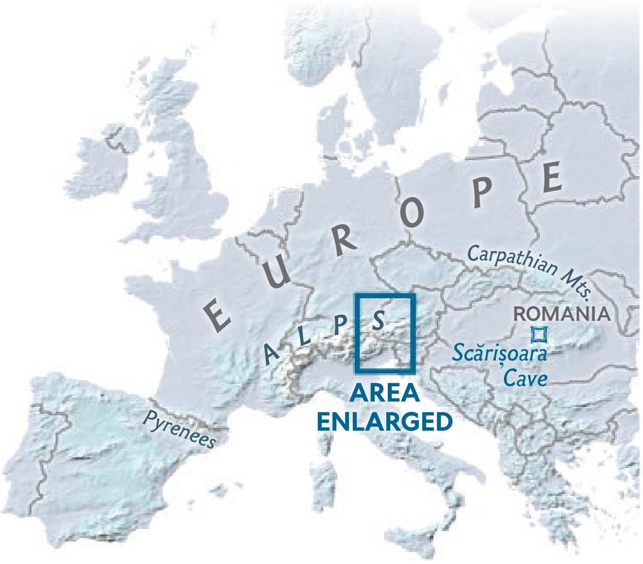
Superstitious ancestors avoided such places, believing that the cold air blowing out of them could only be the devil's breath. Others took a more pragmatic approach and used them as natural refrigerators or even to ice-skate. A few simply came to admire their beauty and sketched them for early science journals.

It would be impossible today to find the formations depicted in such early drawings; too much of the ice has melted. In the process, we're losing not just one of the planet's great wonders but also a clue to its history, says paleoclimatologist Aurel Persoiu of Romania's Emil Racovita Institute of Speleology. "These ice caves are preserving the memory of past climate," he says—much like deep ocean sediments or the ice from polar glaciers.

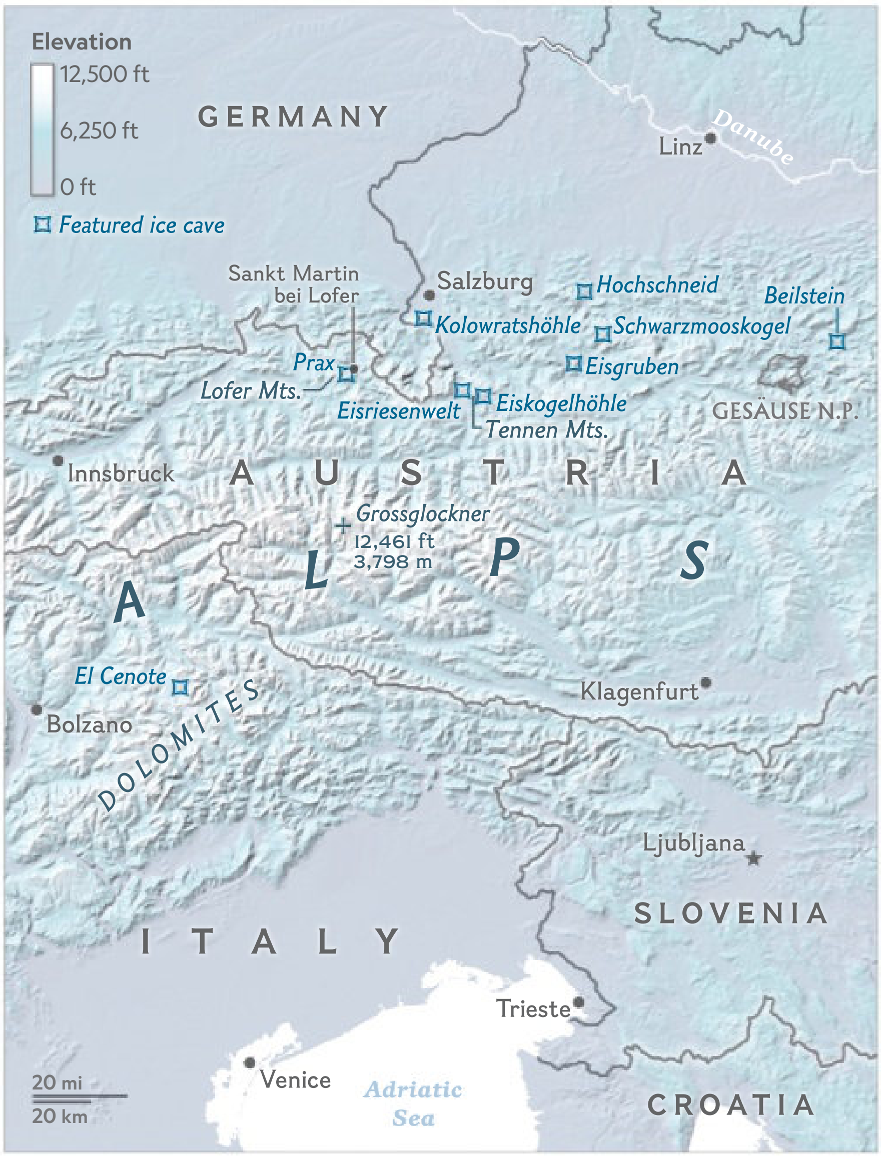
In Scărişoara Cave in Romania's Apuseni Mountains, Persoiu has been climbing down a 150-foot-deep shaft to reach a perennial ice block with a surface the size of seven basketball courts. Carbon-dating bat guano or plant matter trapped inside

HIDDEN ICE GEMS

Thousands of caves that hold ice year-round can be found in European mountain ranges. In the Austrian and Italian Alps, entrances to the ice caves are mainly at elevations of 5,200 to 6,500 feet. As temperatures rise in the mountains, the volume of ice in many caves is shrinking. In some, the ice is no longer perennial: It disappears during the summer, melted by rain and warm air that infiltrate the caves.



EUROPE
Carpathian Mts.
ROMANIA
Scărișoara Cave
ALPS
AREA ENLARGED
Pyrenees



Elevation
12,500 ft
6,250 ft
0 ft
Featured ice cave
GERMANY
Danube
Linz
Sankt Martin bei Lofer
Salzburg
Hochschneid
Beilstein
Kolowratshöhle
Schwarzmooskogel
Prax
Eisgruben
Lofer Mts.
Eisriesenwelt
Eiskogelhöhle
Tennen Mts.
GESÄUSE N.P.
Innsbruck
AUSTRIA
Grossglockner 12,461 ft 3,798 m
ALPS
El Cenote
Klagenfurt
Bolzano
DOLOMITES
Ljubljana
SLOVENIA
ITALY
Trieste
Venice
Adriatic Sea
CROATIA
20 mi
20 km

the ice tells him when it grew or retreated, as the climate cooled or warmed. He has drilled 80 feet into the block without reaching the bottom, and the oldest ice samples he has taken were more than 10,000 years old. When he got that result, he emailed the lab staff to make sure they hadn't added a zero.

Chemical analysis of the ice showed that most of the region's precipitation was from the Atlantic Ocean until about 5,000 years ago, when it pivoted to the eastern Mediterranean Sea. Today another major shift is under way, at Scărişoara and other ice caves in the Alps: Their ice is being decimated by warming air and increased summer rains.

"It's like pouring warm water on the surface of the ice," Persoiu says.

In 2018, not far from Scărişoara, he found a promising new cave he hoped to study. "Four years later, when we went back, there was no ice at all," he says. "It was completely melted."

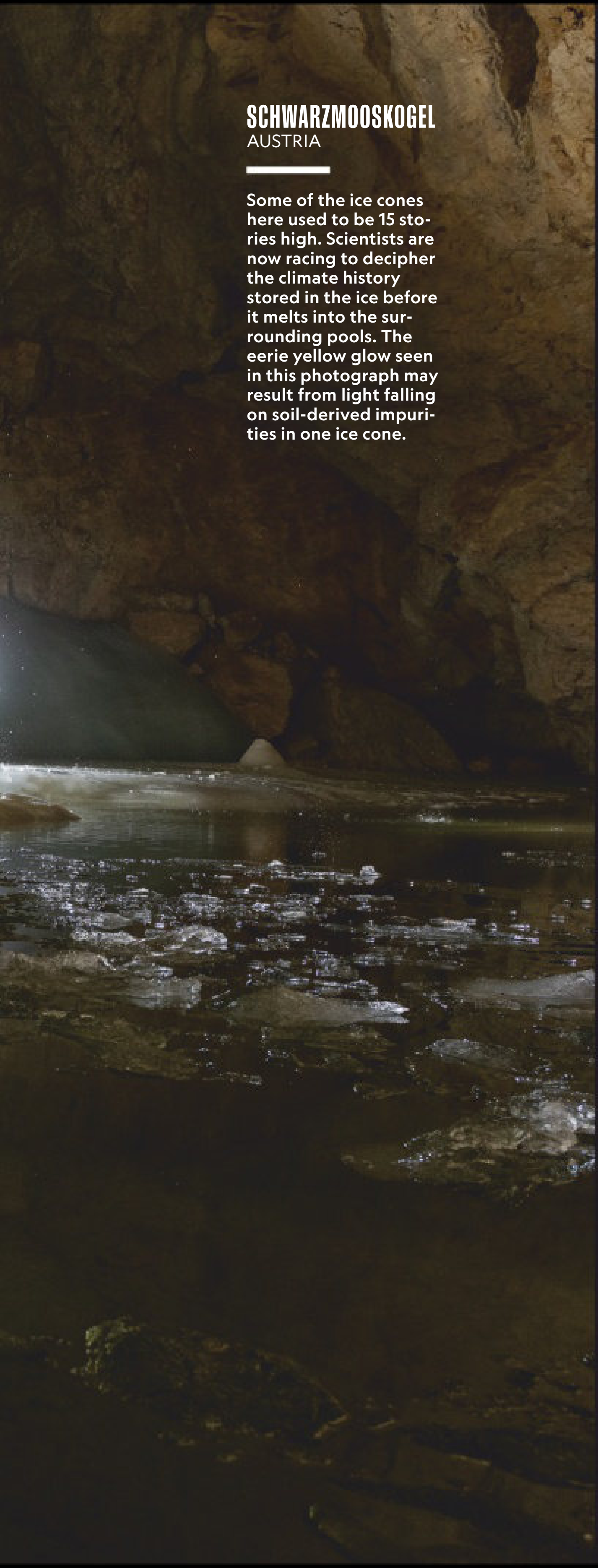
AT A SMALL CLEARING east of Austria's Gesäuse National Park, paleoclimatologist Tanguy Racine zips up his cyan-colored, abrasion-resistant suit and tightens the chin strap on his helmet. It's fall, and wild raspberries dangle from the bushes around him. Above him, a woodpecker is hammering a fir tree, but he is fixated on the dark, gaping hole at his feet. A small plaque marks it as the entrance to Beilstein ice cave.

Years ago, when Racine, a Frenchman, enrolled as a freshman at Imperial College London, he was compelled by the friendly faces at a booth promoting the caving club to join an expedition to a 20-mile-long cave in Wales. He almost got lost—and that's what hooked him. "You might only be five meters from the entrance, but it feels like you're in a different world, away from civilization," he says. Cavers joke that their

RILEY D. CHAMPINE, NGM STAFF. SOURCE: TANGUY RACINE, UNIVERSITY OF INNSBRUCK

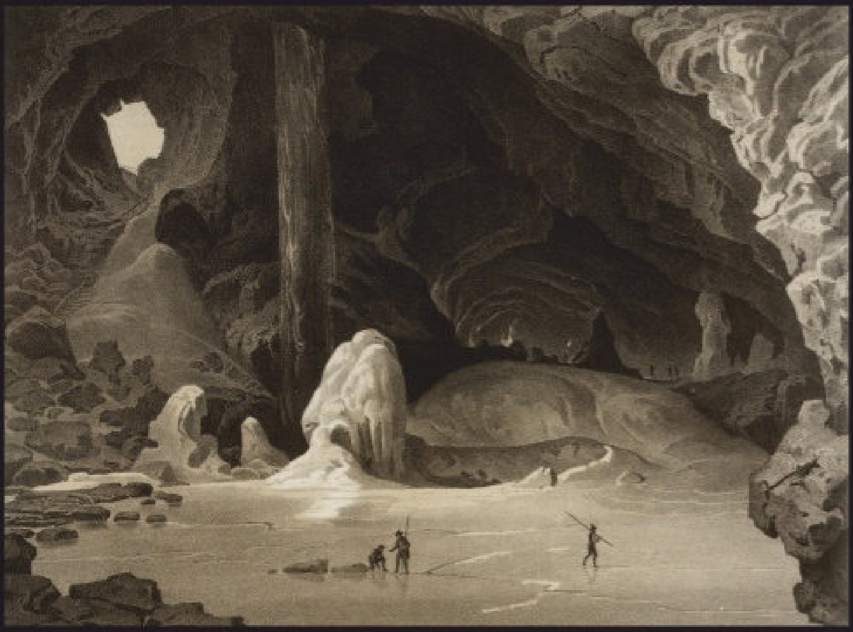
EISGRUBEN
AUSTRIA

Descending a 70-foot wall of ice, Racine (at right) and a colleague pause to extract a sample of it. Racine has found that the ice near the bottom of this 331-foot-deep cave may be 5,300 years old. Ice has accumulated here for most of the past 2,000 years.



SCHWARZMOOSKOGEL
AUSTRIA

Some of the ice cones here used to be 15 stories high. Scientists are now racing to decipher the climate history stored in the ice before it melts into the surrounding pools. The eerie yellow glow seen in this photograph may result from light falling on soil-derived impurities in one ice cone.



KOLOWRATSHÖHLE
AUSTRIA

ABOVE: An 1845 lithograph shows people exploring Kolowratshöhle a few years after its discovery near what's now the German border, west of Salzburg. Some visitors went to ice-skate.

RIGHT: Melting since the 19th century has changed Kolowratshöhle dramatically. Researchers today stand in the same part of the cave seen in the lithograph. It's now devoid of ice.

AUSTRIAN NATIONAL LIBRARY, VIENNA: 272.410-F.1 FID, PLATE 30

hobby is the poor man's space exploration.

Hands wrapped around a rope, Racine and his colleagues from the University of Innsbruck—lead scientist Christoph Spötl, Gabriella Koltai, and Chloe Snowling—begin to rappel into Beilstein. Gingerly, I follow suit. The woodpecker's hammering fades away. At the bottom of the shaft, we land on soft soil and lichen-covered rock, and as we continue almost horizontally, darkness envelops us. A few yards in, the spikes on our hiking boots begin to claw and crunch. We've hit ice.

A drawing of this cave from 1881 shows a man raising a torch in front of a tsunami-like wall of ice, near ice cones dozens of feet tall. Now all that's left is the block of ice beneath our feet. Radar surveys show that it might still be more than 30 feet thick.

Along the rock wall, Racine and Snowling spot a gap where the melting ice has pulled away from the wall, creating a small shaft that leads closer to the bottom of the ice block, and deeper in time. The two squeeze down, chest against rock, back against ice, and disappear. An hour later, when they pull themselves back up on ice axes and ropes, they have fresh material to analyze.

"This is research that couldn't be done previously, and will not be able to be done in 10 years or so, when a lot of the ice is gone," Racine says.

Meanwhile, Koltai and Spötl have assembled a tall auger and begun drilling into the ice from the top. Bit by bit, they retrieve core samples roughly the diameter of a coffee mug. With a miniature handsaw, Koltai slices out smaller chunks to transport back to the lab. As she drops one chunk into a sampling bag and marks the depth—a little over 12 feet—she beams at a dark bit of organic matter trapped inside the ice, from a blade of grass or a leaf that washed into the cave. Radiocarbon measurements will later show it dates as far back as the 15th century.

Much of this scientific information is doomed; the scientists' resources are limited, the ice caves many, and the melt rate rapid. Glaciologists already are planning to transport cores from the Alps' glaciers to Antarctica where, Persoiu says, at least for the foreseeable future, "nothing can go that wrong to melt all the ice." For cave ice, too, researchers are hoping to store samples somewhere safe, to preserve them for future generations to study.

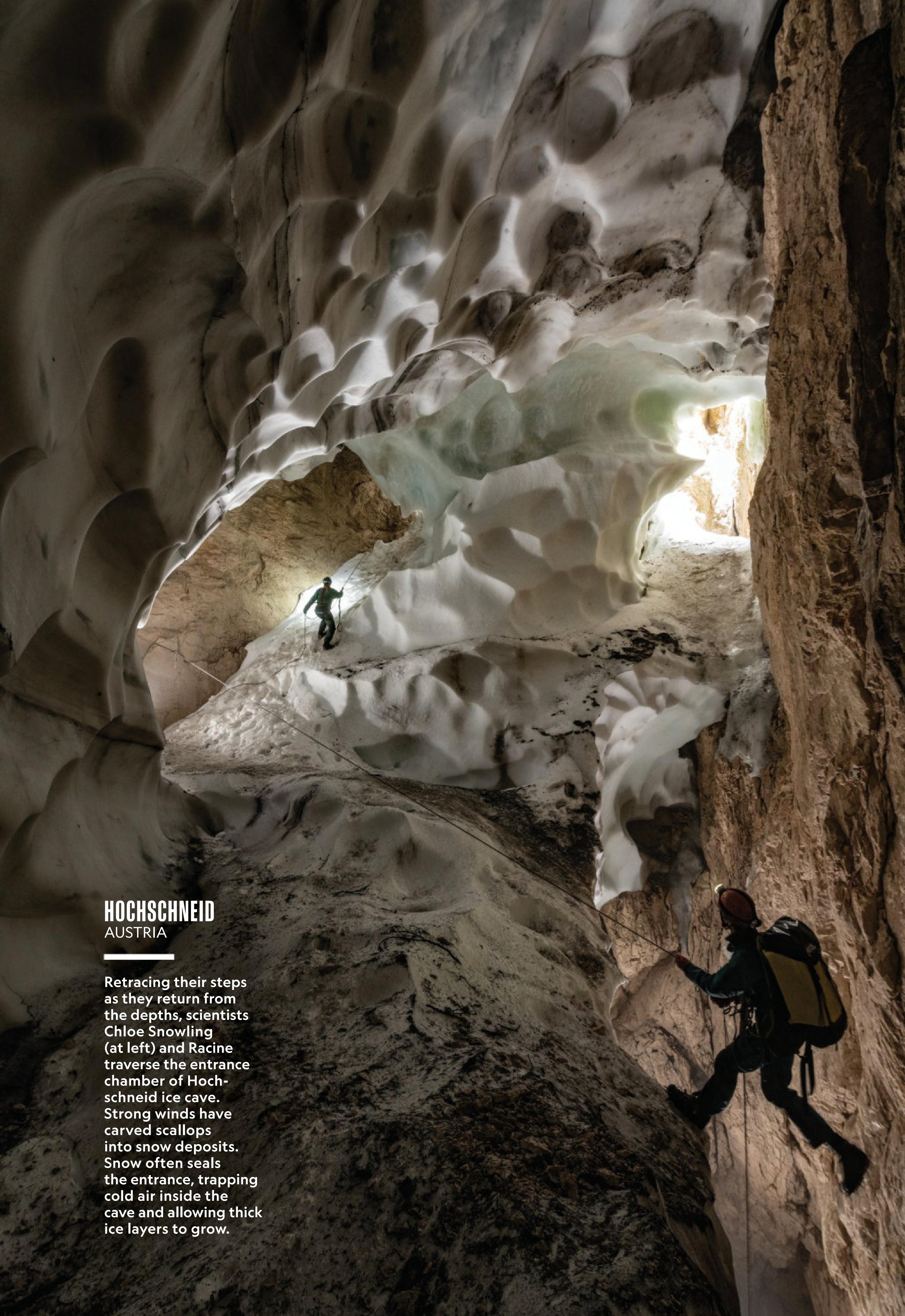
IN THE TENNEN MOUNTAINS I hike up to the largest ice cave on Earth, a place called Eisriesenwelt, or "world of the ice giants." Less than an hour south of Salzburg, it has been a tourist attraction for a century. A door installed in 1920 at the entrance, at about 5,400 feet, likely has helped keep the cave cold during summers, as has a huge chimney effect: The cave exits on the plateau above are more than 1,500 feet higher. When guide Franz Reinstadler flings the door open on this fall day, the gust of wind almost blows me over.

Inside, we climb 700 steps, passing ice cones and wave-shaped formations, the layers of ice ranging from white to an almost electric blue. Even here, they are deteriorating. A 16-foot-thick figure dubbed the Elephant no longer has a trunk. In summer, Reinstadler patrols the cave with a small-caliber rifle, picking off precariously unstable icicles before they can fall on visitors.

When they ask about the effects of climate change, he answers evasively. "There's so much we don't yet understand about the caves, or the ice," he says. But then he adds: "It's best to visit it now." For now, among the ice giants, his breath is still freezing. □

THE MELTING
IS ALLOWING SCIENTISTS
ACCESS TO
FRESH MATERIAL: RESEARCH
THAT COULDN'T
BE DONE BEFORE, OR ONCE
THE ICE IS GONE.

Austrian journalist **Denise Hruby** wrote about warming winters in the Alps for the March issue. Photographer **Robbie Shone** lives in Innsbruck, Austria. He has explored caves for 22 years.



HOCHSCHNEID
AUSTRIA

Retracing their steps as they return from the depths, scientists Chloe Snowling (at left) and Racine traverse the entrance chamber of Hochschneid ice cave. Strong winds have carved scallops into snow deposits. Snow often seals the entrance, trapping cold air inside the cave and allowing thick ice layers to grow.

ÔNIO DE CATEGERÓ

The descendants of people in Brazil who escaped slavery are linked by culture, religion—and resilience.

A RESISTANCE THAT ENDURES

BY **PAULA RAMÓN**

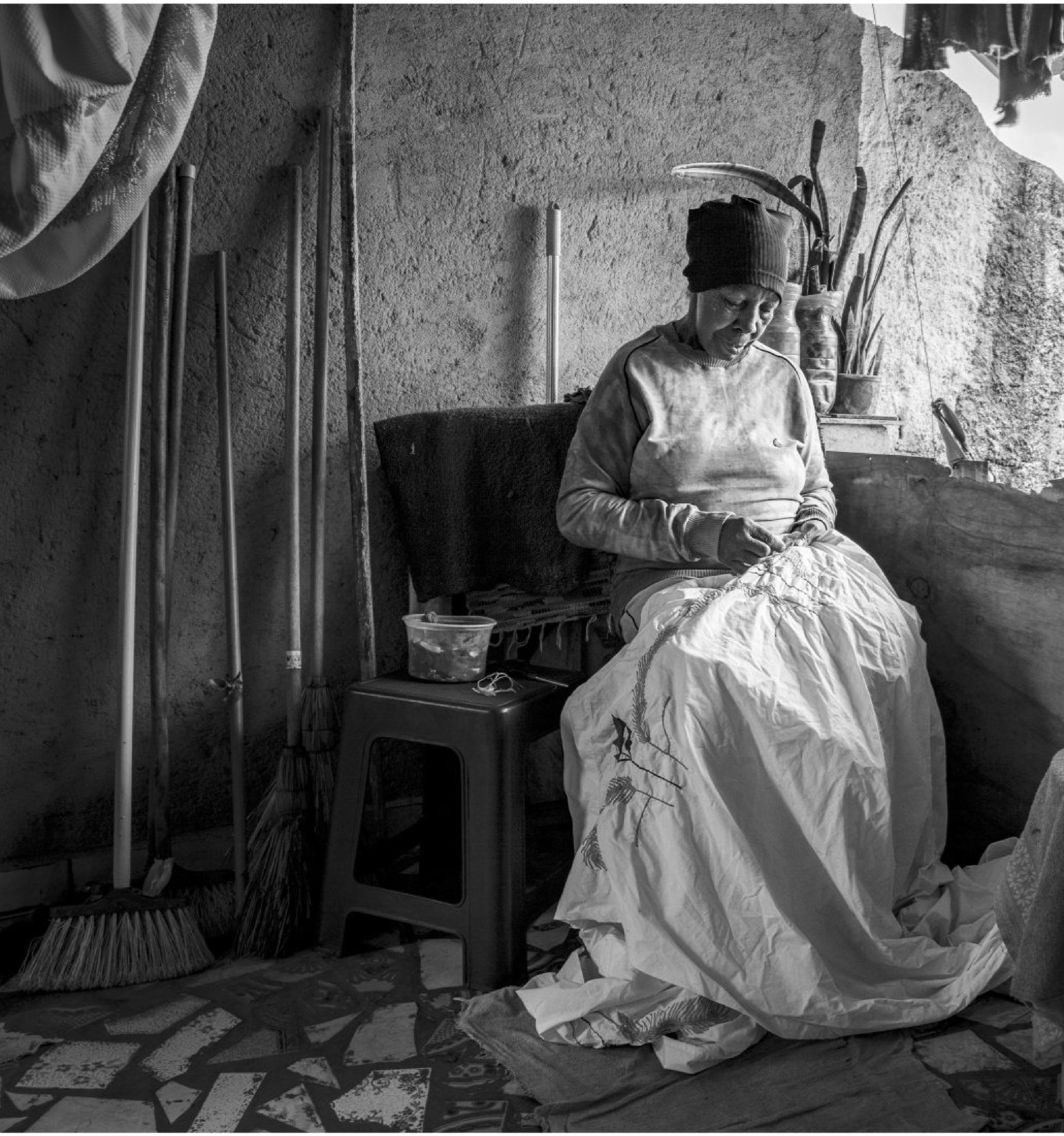
PHOTOGRAPHS BY **MARÍA DANIEL BALCAZAR**

Juliana dos Santos Silva, a Candomblé practitioner, pays homage to her enslaved ancestors at the ruins of a former plantation house in Nova Iguaçu. Africans who escaped slavery in Brazil established communities called *quilombos*—and left a heritage of African culture.

PREVIOUS PHOTO

A service in Salvador brings out a range of reactions at the 18th-century Church of Our Lady of the Rosary of Black People, where many Afro-Brazilians worship, including those who live in nearby quilombos.

In Salvador, Railson Barbosa and Anna Giulia de Oliveira Xavier dos Santos take to the sea with offerings to honor Iemanjá, goddess of the ocean. Originally a deity from the Yoruba faith in Nigeria, Iemanjá is one of the most popular religious figures in Brazil.



Maria José de Deus, now deceased, lived in a quilombo established by her ancestors, formerly enslaved people who escaped their captors. As early as 1530 and for 350-plus years, ships brought almost five million enslaved Africans to Brazil, the last nation in the New World to abolish slavery.

Givânia Maria da Silva knows challenges. She was born in an eastern Brazil community founded by African women who were victims of the Atlantic slave trade.

Like many descendants of enslaved people, Silva, 56, faced racial discrimination—and worse—while growing up in Brazil, the last country in the Western Hemisphere to ban slavery.

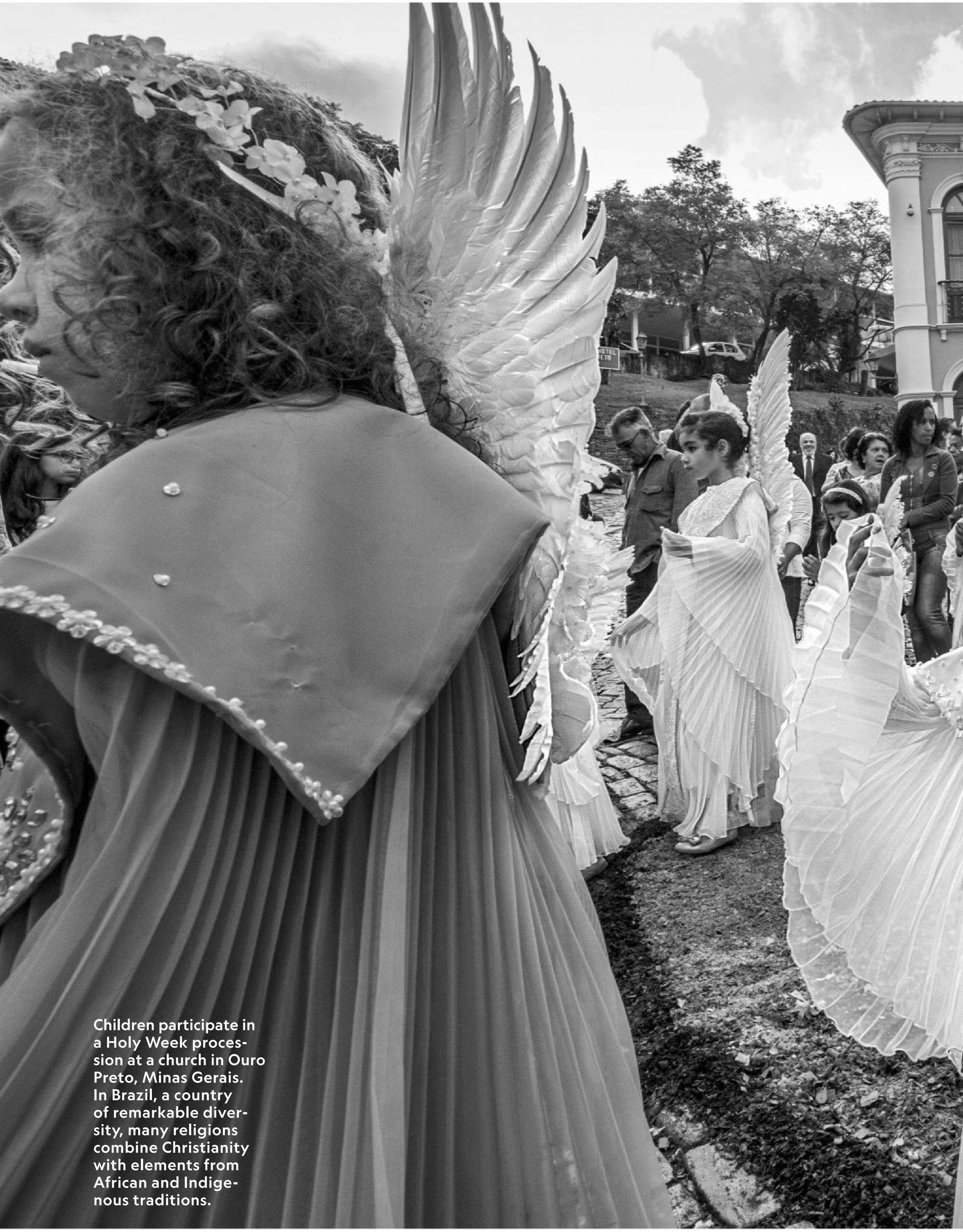
She endured death threats when she was younger, often from outsiders who tried to seize the land where she and her family lived in a *quilombo,* one of the thousands of communities in Brazil established by people who escaped slavery.

Silva went on to become the first woman from Conceição das Crioulas to earn a college degree—an extraordinary achievement in a nation where quilombo residents have long struggled for individual and property rights. It's a part of Brazil's history that is often overlooked.

As a teacher and activist, Silva has devoted 30 years to researching ways to engage students and create curricula that examine the history of quilombos, the violence and oppression that have plagued them for centuries, and the vibrant culture that has thrived within them, despite it all.

It wasn't until 1988—a hundred years after slavery was abolished in Brazil—that the country's

The Moreiras are among 240 families in Pontinha, in Minas Gerais. Like most in the quilombo, theirs is a tight-knit multigenerational household.



Children participate in a Holy Week procession at a church in Ouro Preto, Minas Gerais. In Brazil, a country of remarkable diversity, many religions combine Christianity with elements from African and Indigenous traditions.

A samba dancer plays with her pet cockatiel at home in a favela in Rio de Janeiro. Samba has its origins in African drumming music and developed into its modern energetic style in Rio's favelas in the 1950s.

constitution recognized the property rights of Afro-Brazilians who live in quilombos. But ownership remains rare, and obtaining land titles is still difficult. Persistent inequality and stigmatization continue to be weights on descendants of enslaved people.

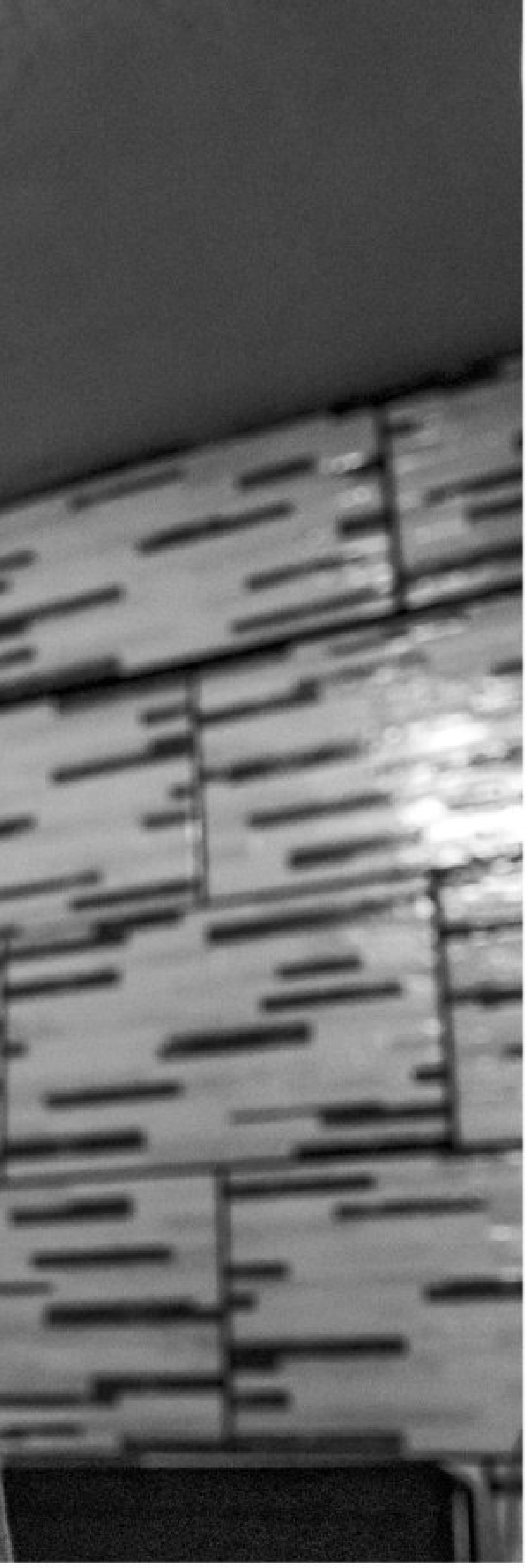
"Abolition is told as something that brought only benefits to Blacks, when in fact the way in which abolition was executed left Blacks on the street, homeless and landless," says Silva, executive director of the National Coordination of Articulation of Black Rural Quilombola Communities (CONAQ). "That remains so."

Quilombos have long been symbols of resistance to bondage and oppression in Brazil. Silva says they represent "the struggle to recognize the rights of Blacks and the role that Blacks played in the whole process of violence that began with their kidnapping from African territory."

Conceição das Crioulas is in the state of Pernambuco and has about 4,000 residents. Women settled there by the beginning of the 19th century, according to oral history, "but we don't know why they came alone," Silva notes.

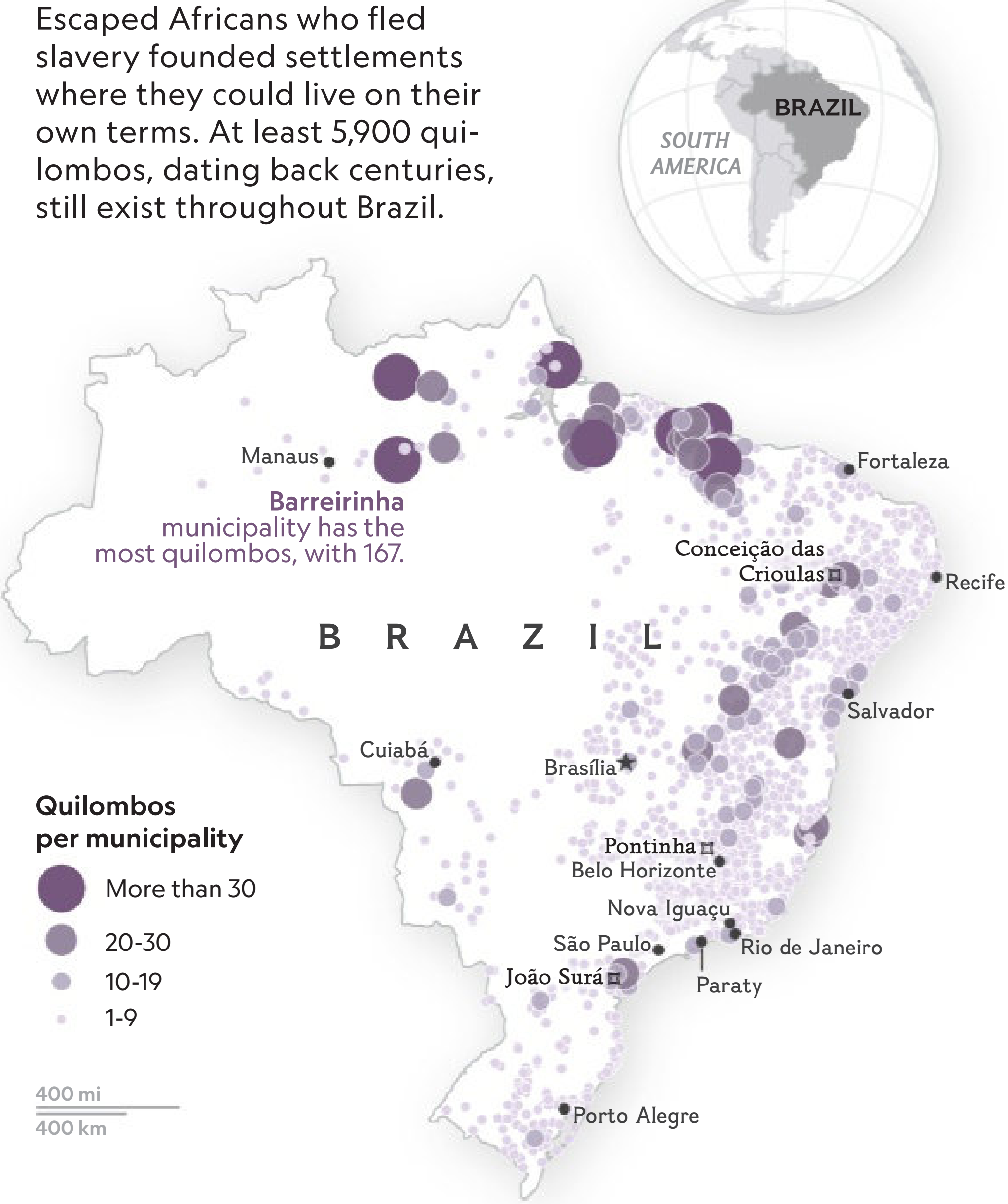
The largest and most famous quilombo, known as Palmares, was in today's neighboring state of Alagoas. It grew to include more than 20,000 residents but was destroyed by Portuguese forces in 1694. The site, although no longer inhabited, is now a memorial park.

Belonging to a quilombo is not primarily about the color of one's skin, Silva says. Rather, the common bond is "the relationship that that group established in the process of resistance to



REMOTE REFUGE

Escaped Africans who fled slavery founded settlements where they could live on their own terms. At least 5,900 quilombos, dating back centuries, still exist throughout Brazil.


BRAZIL
SOUTH AMERICA
Manaus
Fortaleza
Conceição das Crioulas
Recife
B R A Z I L
Salvador
Cuiabá
Brasília
Pontinha
Belo Horizonte
Nova Iguaçu
São Paulo
Rio de Janeiro
João Surá
Paraty
Porto Alegre
Quilombos per municipality
More than 30
20-30
10-19
1-9
400 mi
400 km

Barreirinha municipality has the most quilombos, with 167.

MATTHEW W. CHWASTYK, NGM STAFF
SOURCE: BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS

slavery. The word was taken to mean a group of people who fight, who resist, who reorganize."

AS EARLY AS 1530 and continuing for 350-plus years, ships brought more enslaved Africans to Brazil—some 4.8 million—than to any other nation in the Americas. By 1888, when slavery was formally abolished, many captives had escaped and founded their own communities.

Official statistics show that an estimated 1.1 million people live in about 5,900 quilombos spread across the country (CONAQ places the number of quilombos at about 6,500). Today, 34 years after Brazil recognized property rights for people of African descent living in quilombos, less than 10 percent of the communities have been granted protected status by the government, which would safeguard them from development, similar to Indigenous lands.

Nearly 56 percent of Brazilians—about 119 million people—say they're of African descent, according to the Brazilian Institute of Geography and Statistics. Even so, the majority of leadership positions in business, politics, and the arts are held by whites. The average income of Afro-Brazilians is not much more than half that of whites, a 2020 study by the institute indicates. That wage-gap ratio has barely changed in at least a decade.

"In the city, the bosses want us for manual labor. We work a lot but earn very little, so it is still a slave process," says Benedito de Freitas, 42, who lives in Comunidade Remanescente Quilombola João Surá in the southeastern region of Brazil.

A girl visits a cemetery in Rio de Janeiro where devotees of African-derived religions, widely practiced in quilombos, honor their loved ones during Day of the Dead, or Dia de Finados.

67104
67049
67031
67013

VIAMARTE

Women wearing outfits with ties to African ancestry prepare to take part in a religious procession at a church in Paraty.

Like those in the other 55 families there, de Freitas has ancestors who fled enslavement at the region’s gold mines and settled in the jungle. “If we exist today, it is because our ancestors sought freedom,” he says. “It is here [in quilombos] where they respect Black men and women, even when they are oppressed.”

FOR RESIDENTS, quilombos are an anchor of power in the push for racial justice, cultural identity, and religion. “We have a diversity of expressions in religion, dance, and music, whose dimensions are connected,” says historian Cassius Cruz.

Roman Catholicism is the dominant religion in Brazil, but evangelicalism is gaining ground. The percentage of those who say they practice religions of African origin also has increased, according to the official figures. One of the most popular is Candomblé, which includes music, dance, and other ritual expressions.

“For me, it’s really about ancestry,” says Juliana dos Santos Silva, 37. She had an evangelical upbringing in Rio de Janeiro, but her grandparents and great-grandparents practiced Candomblé. Santos Silva was introduced to it 11 years ago when she attended a ceremony to honor a deity. “I was captivated by the energy and joy of the people singing and celebrating,” she says, adding that the religious practices helped her mourn her father’s death and gave her a special connection to her grandparents.

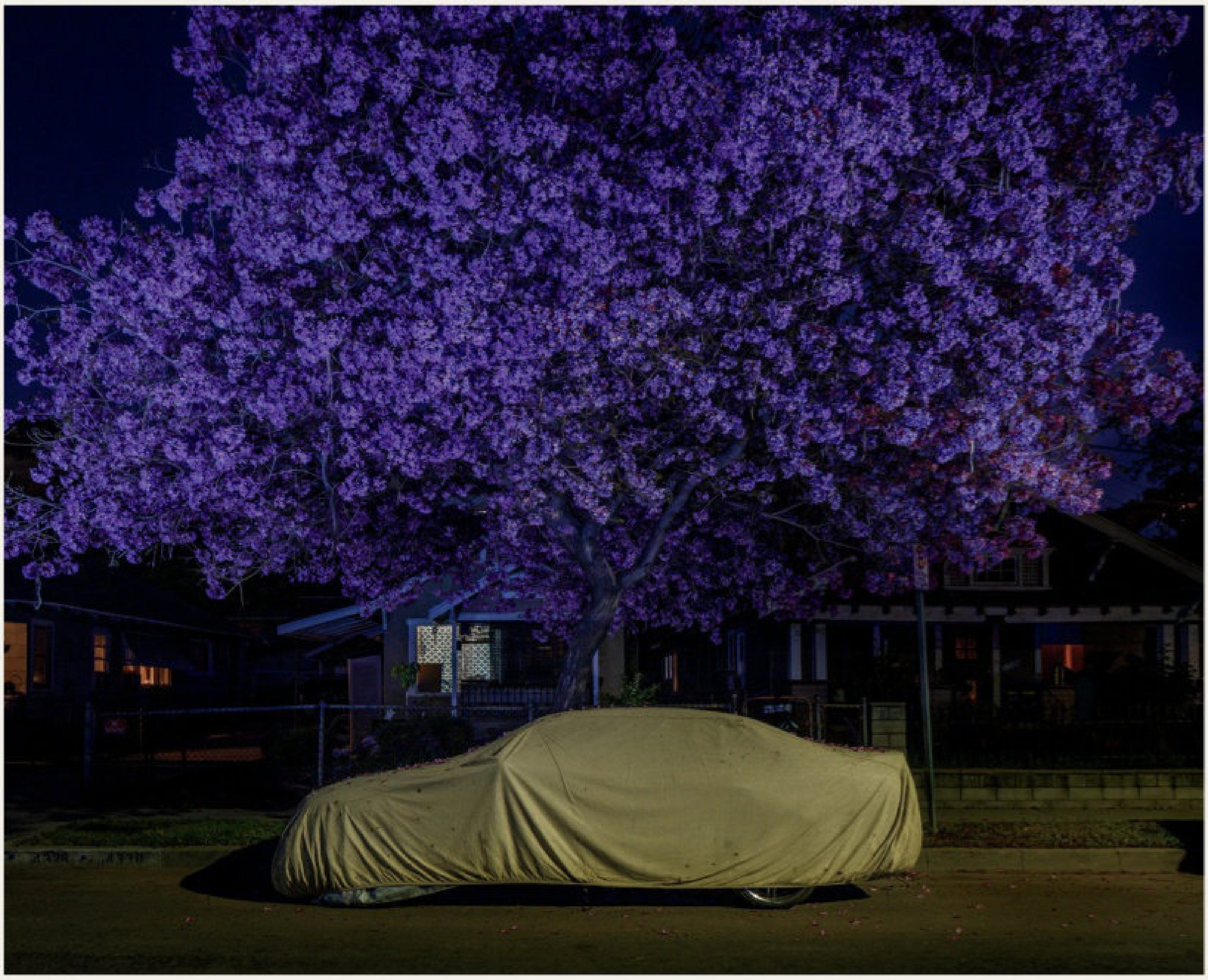
Still, some Candomblé believers are wary of practicing openly. Places of worship known as *terreiros* have been vandalized, and in 2021 the Ministry of Women, Family and Human Rights recorded 681 violations of freedom of religion or belief. “Many of my friends keep religion hidden,” Santos Silva says.

Franklin Moreira, who belongs to a religious folkloric ensemble with African roots in southeastern Brazil’s Minas Gerais, says it’s important to educate others about the history of quilombos, what they represent culturally and spiritually, and the role they have had in the growth of Brazil.

“We have to, with wisdom, show people that these are sacred places, where our ancestry is manifested, and therefore it has to be respected,” says Moreira, 30. “It is an ancestral legacy that we carry,” he adds. “This Brazil we know, with this culture, only existed thanks to the strength of our ancestors. They suffered a lot; they lived unimaginable pains. That is why it is so important to keep our quilombos alive, because they keep us resisting.” □

Venezuelan writer **Paula Ramón** lives in Los Angeles. **María Daniel Balcazar** is a documentary photographer who explores traditions as sources of strength.

At a cemetery in Nova Iguaçu where enslaved people are buried, Juliana dos Santos Silva honors her ancestors. It's a "mystical place, full of energy," she says, "a place that has a lot of strength and great meaning."



INSTAGRAM

GERD LUDWIG

FROM OUR PHOTOGRAPHERS

WHO

A German-born, U.S.-based documentary photographer

WHERE

Montecito Heights in Los Angeles

WHAT

Canon 5D Mark III with a 24mm tilt-shift lens

Ludwig, who lives in Los Angeles, often spends his nights photographing cars at rest. “Like a devoted bird-watcher, I’ve learned to recognize their sleeping patterns,” he says. Ludwig wanders the streets until he finds a vehicle that speaks to him; perhaps it’s lit by the moon or sheltered by a tree in full bloom. Police sometimes question him, but after he shows them images on his camera, they relax—and even tip him off about the next potential sleeper subject.

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